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CERCLA Site Inspection Report Purpose:

Nanabah Vandever Abandoned Uranium/Vanadium Mine Site:

(Part of Bluewater Uranium Mine) Haystack Mountain-Ambrosia Lake Area

35°20'47" N-latitude; 107°57'0" W-longitude Baca Chapter, Navajo Nation

Prewitt, McKinley County, New Mexico 87045

986669109

NND983469891 Site EPA ID Number:

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Date of Inspection: November 13-16, 1990

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Navajo Superfund Program

Navajo Environmental Protection

Administration

Division of Natural Resources

Navajo Nation

Report Date: March 30, 1992

FIT Review/Concurrence:

Submitted To: Paul La Courreye

EPA Region IX

Site Assessment Manager

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), Region 9, under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) has tasked the Navajo Superfund Program (NSP) to develop a Site Inspection (SI) Report for the Nanabah Vandever (NV) abandoned uranium/vanadium mine site in Haystack, McKinley County, New Mexico. The NV site has been combined with the adjacent Brown Vandever (BV) mine site but is evaluated separately in this report.

The NV mine site was identified as a potential hazardous waste site and entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) in March 1990. EPA was notified of the site by NSP. A Preliminary Assessment (PA) was performed by NSP in June 1990. The purpose of the PA was to review existing information on the site and its environs, to assess the threat(s) posed to public health, welfare, or the environment, and to determine if further investigation under CERCLA was warrented. EPA recommended further investigation of the NV site to more completely evaluate the site using EPA's Hazard Ranking System (HRS) criteria. The HRS assesses the relative threat associated with actual or potential releases of hazardous substances from the site. The HRS is the primary method of determining eligibility for placement on EPA's National Priorities List (NPL). The NPL identifies sites at which EPA may conduct remedial response actions. Subsequent response action (reclamation) was directed by the EPA Region 9 Emergency Response Section (ERS) due to the imminent hazards posed by the site. This SI Report is the result of a joint investigation performed by ERS and NSP.

1.1 Apparent Problem.

Presently on the NV site, there is documented soil contamination with a potential for air migration [1]. The sources of contamination are unreclaimed radioactive mine tailings and an open mine portal [2]. High gamma radiation levels signify soil contamination. (Contamination and potential sources are described in Section 4.1.) The radioactive mine tailings have a potential to migrate via surface runoff and by wind. Part of the NV site and all of the BV site were recently reclamated under ERS supervision. Radiological hazards at the reclamated areas have been diminished [3].

In 1988, the Department of Interior's (DOI) Bureau of Land Management (BLM) informed the Navajo Environmental Protection Administration (Navajo EPA) of the many unreclaimed Haystack area mines and of the potential radon threat to the Navajo residents located near the mines (NSP is within Navajo EPA)[4]. EPA review

of the NV PA led to a recommend of an SI. Due to health risks from the the presence of radioactive mine tailings, physical hazards, and potential for heavy metal contamination, on November 15-16, 1990, ERS performed a geochemical and georadiological study of the BV-NV sites to assess the environmental and physical hazards [1]. Elevated concentrations of radioactive isotopes were detected in on-site soils [1]. Soil samples did not reveal any significant heavy metal contamination [1]. A more thorough gamma survey was conducted on August 11-19, 1991 by the ERS. Within the BV-NV sites, waist level and ground contact level gamma radiation readings were significant [1]. Detailed analytical results are in Section 3.0.

2.0 SITE DESCRIPTION

2.1 Site Location.

The NV site consists of abandoned uranium/vanadium mines in eastern McKinley County, NM (SEl/4, SEl/4, Sec.13 and NEl/4, NEl/4, Sec.24 of Tl3N, RllW, NM Meridian; Lat.: 35°20'47" N, Long.: 107°57'0" W)[5]. The site is adjacent to Haystack Butte on grazing land 4 miles east of Prewitt, NM [Fig.1]. The NV PA assessed both the 1/4 section NV claim in Sec.24 and an adjacent 1/4 section claim in Sec. 13 known as NM-B-l lease, and controlled by the Department of Energy (DOE)[6]. The NV claim, the BV site, and the nearby Desiderio Group mines comprise the Bluewater Uranium Mine site (NND983469891) which recently received ERS reclamation. The NV claim is on Indian Allotment land where DOI's Bureau of Indian Affairs (BIA) has pervasive power over the land, and the Navajo Tribe has no consent privileges. DOE's claim was withdrawn from the public domain under Public Land Order 964 for use by the Atomic Energy Commission, a predecessor of DOE.

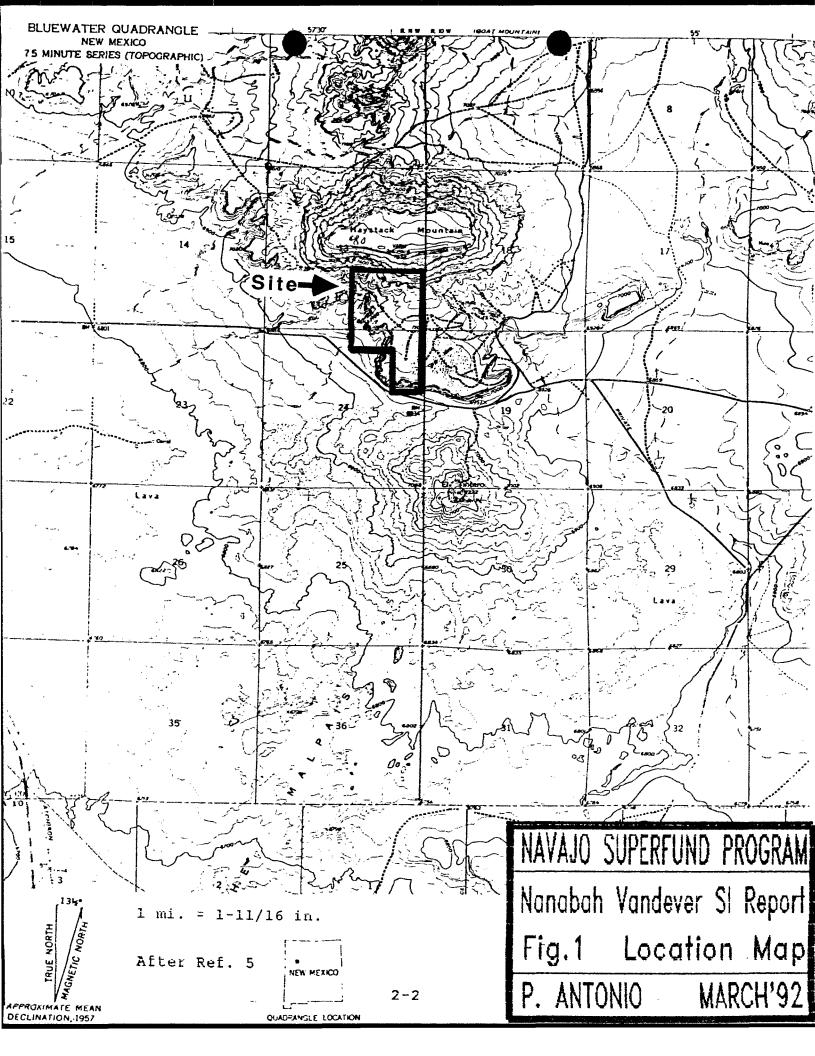
2.2 Site Description.

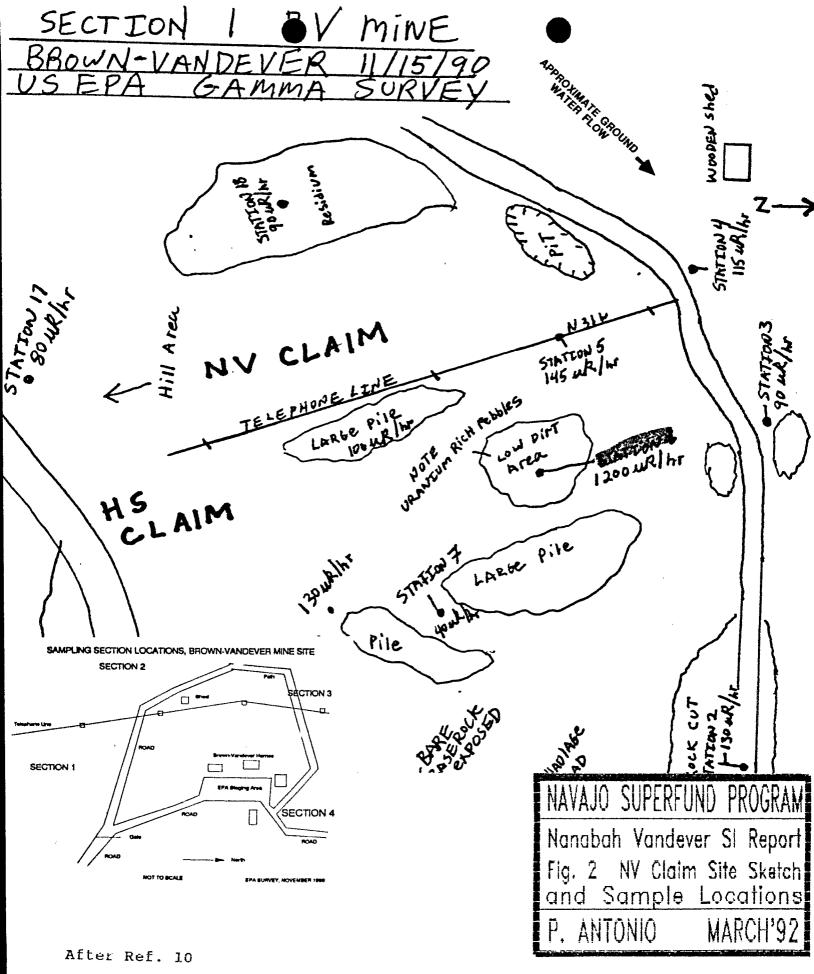
Only the NV claim received ERS reclamation, none was performed on DOE's claim. In pre-reclamation conditions, the NV claim consisted of an open-pit mine and about 52,600 cubic yards (yd³) of mine tailings [2; Fig.2]. A portion of the DOE claim had earlier open-cut mining partially reclaimed (not by ERS). Later mining on the DOE claim left an open mine portal and about 68,370 yd³ of tailings material [2; Fig.3]. NV claim post-reclamation conditions have the open-pit filled and the tailings covered, recontoured and reseeded [1]. Residents are downgradient of the unreclamated DOE claim. See Appendix A for Photodocumentation of the NV site.

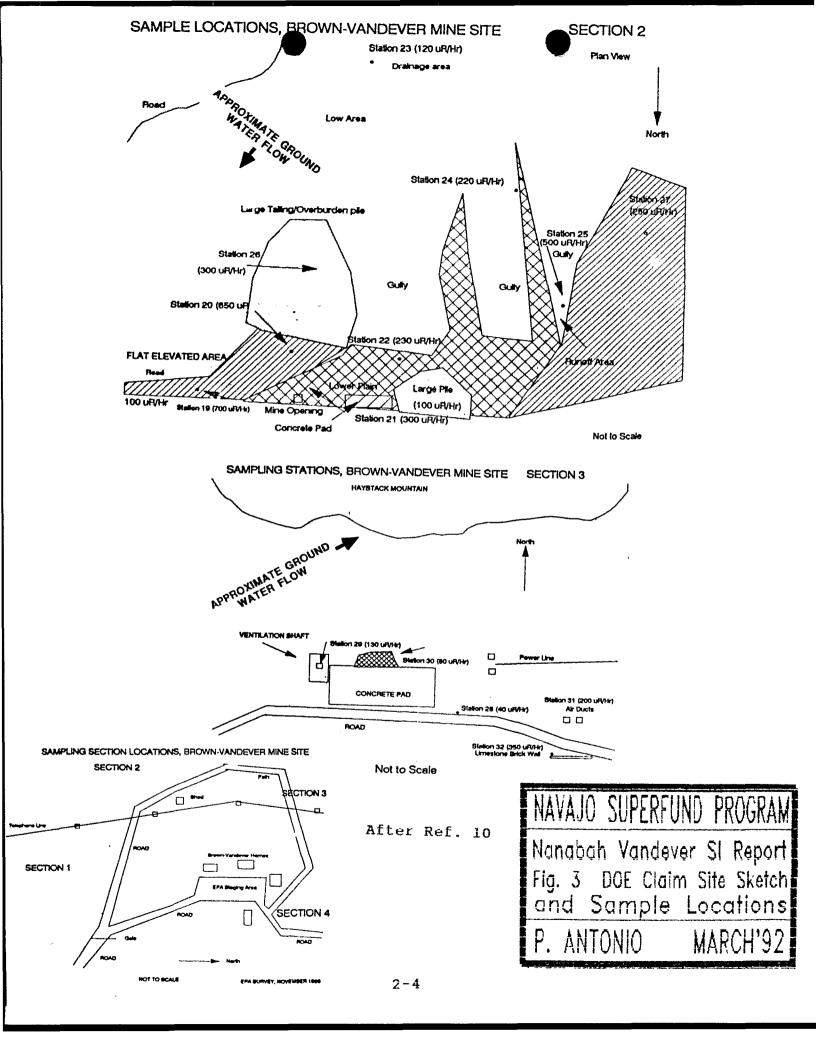
2.3 Operational History.

The NV claim operated through Tribal leases administered by the BIA [2]. Operators and operation periods included: Glen Williams (1952-54); Santa Fe Uranium (1955-56); Santa Fe Uranium and Federal Uranium Corp. (1956-57)[6]. Once operations ceased in 1957, the NV property was relinquished to the allotment owner. DOE's NM-B-1 lease was first operated by the Haystack Mountain Development Corp. (1958-61) and next by Todilto Exploration and Development Corp. (1975-81)[1]. Presently, Todilto Exp. and Dev. Corp. still holds a valid lease on the DOE portion of Sec. 13 [1].

The uranium ore mined was predominantly calcium carnotite in the host Todilto Limestone [1]. Operations involved underground mining techniques (mine adit) for deeper ore deposits on the DOE claim







claim and strip mining for shallower ore deposits on both the NV and DOE claims [2]. Overburden was blasted, removed, and put in large piles. Ore failing to contain significant quantities of uranium was discarded on-site [2]. Higher-grade ore was shipped off-site to processing mills. For the NV claim and most of the DOE claim, no formal reclamation program was instituted after mining ceased, so mine workings and tailings were left intact with no prevention of physical, chemical or radiological hazards.

The NV claim produced 24,638 tons of ore yielding 115,075 lbs of U₂O₃ (0.22%) and 85,545 lbs of V₂O₄[6]. The DOE claim produced a total of at least 137,310 tons of ore yielding 216,701 lbs of U₂O₈ $V_{2}O_{5}[6]$.

2.4 Regulatory Involvement.

NSP through a site assessment cooperative agreement with EPA conducted a PA for the NV site. Following review of the NV PA, EPA recommended the site for SI. The Agency for Toxic Substances and Disease Registry (ATSDR) issued a health advisory for the Bluewater Uranium Mine site based on the presence of uranium-containing radioactive mine wastes, areas potentially contaminated with heavy metals, and many physical hazards [7]. ERS was notified by ATSDR on the potential hazards and proceeded to collect site data and, ultimately, oversaw reclamation on most of the BV-NV sites. Only Sec. 13 failed to receive reclamation because it is under the jurisdiction of the Department of Energy [8].

Since leasing of the NV claim was managed through the BIA (DOI) and leasing for the DOE claim was overseen by DOE, EPA and NSP met various times with, or contacted, the following parties in an attempt to work out an agreement on needed cleanup:

For the NV Claim: DOI Administration

Office of Surface Mining (within DOI)

BIA (within DOI) BLM (within DOI)

Navajo Abandoned Mine Lands New Mexico Abandoned Mine Lands

Indian Health Service (IHS)

For the HS Claim: DOE

Todilto Exploration & Development Corp.

EPA carried out response actions on the NV claim hoping that identified potential responsible parties (BIA/DOE) would finance, wholly or partially, the cleanup efforts. Presently, this has yet to transpire. DOE has assumed responsibility in overseeing response actions on Section 13 [8]. DOE is presently trying to work with the mine lessee, Todilto Exp. & Dev. Corp., for required actions.

3.0 INVESTIGATIVE ACTIVITIES

3.1 Previous Sampling.

No previous sampling has apparently occurred. NSP obtained elevated gamma radiation levels at downwind and downgradient areas of the site during the PA investigation and pre-response action period.

3.2 EPA Sampling.

On November 15-16, 1990, ERS collected pre-reclamation environmental samples from the Bluewater Uranium Mine sites. In the post-reclamation week of September 15, 1991, ERS collected 4 composite soil samples (for analysis of uranium isotopes and Radium 226) from the soil cover on the NV claim.

3.2.1 Purpose and Description of Sampling Event. EPA's prereclamation sampling event involved collecting soil, air, surface
water and groundwater samples for analysis of heavy metals and
radioactivity to characterize the amount and extent of contamination associated with the mine tailings and to assess the health
impacts associated with the tailings due to environmental and
physical hazards [1]. ERS performed the geochemical and georadiological studies of the Bluewater Uranium Mines sites.

Sampling occurred as indicated in ERS's Preliminary Assessment Workplan dated November 9, 1990 [9]. For the NV site, the workplan called for: an initial gamma radiation survey to determine external radiation hazards associated with the site; collection of soil samples from tailings and downdrainage areas; collection of on-site surface water samples, if present; and, collection of groundwater from area wells and nearby house taps [9]. The soil and water samples were analyzed for radioactivity (uranium and radium isotopes) and heavy metal concentrations [10]. Figures 2 and 3 depict sample locations. Table 3-1 has sample location rationale.

- 3.2.2 Deviation from Sampling Plan. Due to the lack of on-site surface water, no surface water samples were collected. Instead, more groundwater samples were obtained than originally planned.
- 3.2.3 Discussion of Sample Results. The NV site pre-reclamation analytical results indicate: soil samples 5A, 6A, 7A and 21A, within the mined areas, exceeded the promulgated standard for Radium-226; soil samples did not reveal any significant amount of heavy metal contamination; and, there was no evidence that the groundwater has been affected by hazardous substances at the site [10]. The initial groundwater sample (Sample #W7) from the Preschool well (livestock use) indicated highly elevated radionuclide levels, likely due to laboratory/sampling error [10]. A re-sample (Sample #W8) of the Pre-school well by the IHS indicated low

Table 3-1 SAMPLE LOCATION AND RATIONALE

Sample Type S	ample #	Location	<u>Rationale</u>
Soil/Tailings	1 A	Station 20 (DOE) Flat Elevated Area	Constituent Concentration a of Source Material
Soil/Tailings	<u>ī</u> D	Station 20 (DOE)	lA Duplicate (QA/QC)
Soil/Tailings	10	Station 20 (DOE)	1A Spike (QA/QC)
Soil/Tailings	1D	Station 20 (DOE)	lA Spike Dup. (QA/QC)
Tailings	2A	Station 22 (DOE) Lower Plain	Constituent Concentration of Source Material
Soil	ЗА	Station 23 (DOE) Drainage Area	Off-site Contaminant Transport Downstream
Soil	4A	Station 25 (DOE) Upper Drainage	*1
Soil	21A	Station 30 (DOE) Drainage Area	** 11
Soil	9 A	Road to BV	Background Concentration
Groundwater	Wl	Well 16T-522	44 49
Groundwater	WlD	77 77	Duplicate (QA/QC)
Groundwater	Wls	77 27	Spike (QA/QC)
Groundwater	WlsD	77 77	Spike Duplicate (QA/QC)
Groundwater	W2	Well 16T-551	Off-site Contaminant Transport Downgradient
Groundwater	WЗ	B. Vandever Tap	11 11
Groundwater	W4	PWS Waterline	fT 11
Groundwater	W7	Preschool Well	***
Groundwater	8W	77 11	Re-Sample of W7

radium levels, but gross alpha was just over the MCL [11]. IHS requested re-painting the "LIVESTOCK USE ONLY" sign on the well's water storage tank [11]. Table 3-2 has results of the metals analysis. Table 3-3 has results of the radionuclides analysis. Reference No. 10 contains all laboratory analytical documentation.

The four NV site post-reclamation soil samples were obtained from the reclamated cover material and at a random background locale. The soil sampling data (Total Uranium and Radium 226) revealed the reclamation successfully reduced any potential surface radiological hazard [3]. No sample exceeded the regulatory standard of 5 pico-Curies per gram (pCi/g) over background pursuant to 40 CFR Section 192 [3]. Results of the BV site post-reclamation soil sampling analysis are as follows:

Sample ID	Total Uranium	<u>Radium 226</u>
BV24A	7.0 pCi/g	3.7 pci/g
BV24B	3.6 pCi/g	3.2 pCi/g
BV24C	3.2 pCi/g	2.9 pCi/g
*BV24D (bkgrd)	0.55/0.64 pci/g	0.73/0.90 pCi/g

^{*} Analyzed as a duplicate sample.

Overall, the pre-reclamation sampling analytical results revealed that contamination on the BV-NV sites was primarily confined to onsite soil radiation (Radium-226), especially in disturbed mine areas [1]. (A documented measurement of high radon-flux off tailings material was obtained prior to ERS response from the Desiderio Group mines.) However, post-reclamation sampling analytical results indicated both gamma radiation and radionuclide concentrations at the NV site have been significantly reduced to "natural" or background conditions [3]. Background gamma radiation level was determined to be about 11 microRoentgens per hour (uR/hr)[1].

Table 3-2. Results of Metals Analyses

Sample No. and Location	Al	(Benchma		ents parent Cr	hesis) Pb	Mg
		Soi	l Samp	les in 1	mg/kg	
	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
1A Station 20 (DOE) (Flat Elevated Area)	4107	1.6	221	ND	17.9	2770
1D 1A Duplicate	3360	1.8	154	ND	14.4	1360
lD lA Spike	12300	NA	368	137	NA	4130
1D 1A Spike Dup.	13950	NA	408	139	NA	4540
2A Station 22 (DOE) (Lower Plain)	2120	0.3	86.2	ND	4.1	1300
3A Station 23 (DOE) (Drainage Area)	1830	0.7	106	ND	4.1	993
4A Station 25 (DOE) (Upper Drainage)	1240	0.5	76.4	ND	1.7	612
18A Station 30 (DOE) (Drainage Area)	3450	1.2	90.8	ND	3.0	1400
9A Road to BV (BKGRD)	3060	0.8	4930	ND	3.9	1480
		Water Samples in mg/L				
	(N/A)	(0.05)	(1.0)	(0.05)	(0.05)	(N/A)
Wl Well #16T-522 (Livestock Use)	ND	0.003	ND	ND	0.002	11.7
W2 Well #16T-551 (PWS Well)	0.042	ND	ND	ND	0.013	2.08
W3 B. Vandever Tap	ND	ND	0.03	ND	ND	1.76
W4 PWS Waterline	ND	ND	0.03	ND	ND	ND
W7 Preschool Well (Livestock Use)	1.06	ND	ND	ND	0.006	1.61

N/A: Benchmark not available.

ND: Not detectable. NA: Not Applicable

Table 3-2. Continued

					,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Mn	-				V
WWW. William Control (2007) 1000	and the second s	O Port Indiana			6-79 °
(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
260	ND	0.9	150	26.0	474
250	ND	1.5	130	9.0	465
453	154	NA	NA	139	738
461	150	NA	NA	97	791
146	ND	<0.2	162	20.0	105
151	ND	<0.2	103	15.0	53.4
142	ND	<0.2	24.3	10.8	8.28
109	ND	<0.2	23.0	28.9	7.59
2580	ND	<0.2	35.l	25.1	6.07
Water Samples in ug/L					
(0.05)	(0.1)ª	(0.01)	(N/A)	(N/A)	(N/A)
0.103	0.052	<0.002	11.2	ND	ND
ND	ND	ND	ND	ND	ND
ND	ND	ND	0.12	ND	ND
ND	ND	ND	2.55	ND	ND
0.02	ND	ND	0.12	ND	0.22
	(N/A) 260 250 453 461 146 151 142 109 2580 (0.05) 0.103 ND ND ND	Mn Mo Soil (N/A) (N/A) 260 ND 250 ND 453 154 461 150 146 ND 151 ND 142 ND 109 ND 2580 ND Wa: (0.05) (0.1) ^a 0.103 0.052 ND ND ND ND	Mn Se Sample	Mn Mo Se Sr Soil Samples in mo (N/A) (N/A) (N/A) 260 ND 0.9 150 250 ND 1.5 130 453 154 NA NA 461 150 NA NA 146 ND <0.2	Mn

N/A: Benchmark not available.
ND: Not detectable. NA: Not Applicable.
a: Benchmark from 40 CFR 192.02(a)(3) Table 1

Table 3-3. Results of Radiometric Analyses

Sample No. and Location	บ-233/234	U-235 (Benchma	Isotopes U-238 rks in Par	Ra-226 enthesis)	Ra-228
		Soil	Samples in	pCi/g	
	(N/A)	(N/A)	(N/A)	(5.0) ^b	(N/A)
1A Station 20 (DOE) (Flat Elevated A		13.0	250.0	300.0	1.0
2A Station 22 (DOE) (Lower Plain)	25.0	1.0	25.0	34.0	0.0
3A Station 23 (DOE) (Drainage Area)	21.0	0.8	20.0	24.0	0.0
4A Station 25 (DOE) (Upper Drainage)	3.4	00.1	3.5	4.7	0.0
18A Station 30 (DOE (Drainage Area)	0.7	00.1	0.8	0.8	1.0
9A Road to BV (BKGR	0.6	13.0	000.7	00.8	0.0
		Water	Samples i	n pCi/L	
	·χ`* (U	-234/238	= 30) (Ra-226/228	8 = 5.0)
W1 Well #16T-522 (Livestock Use)	2.0	00.3	0.4	00.8	2.0
W2 Well #16T-551 (PWS Well)	0.5	00.0	0.0	00.2	0.0
W3 BV Tap	2.1	1.0	0.8	00.2	0.0
W4 PWS Waterline Up Dip I.G.	**************************************	0.5	0.5	0.1	0.0
W7 Preschool Well (Livestock Use)	130.0	3.0	74.0	1.0	22.0
		Gross Alp	ha		
		(15.0)			
W8 Re-Sample of W7		15.5		0.0	0.0

N/A: Benchmark not available. b: In top 15 cm.

4.0 HRS FACTORS

The HRS is a scoring system used to assess the relative threat associated with actual or potential releases of hazardous substances from sites. It is the principal mechanism EPA uses to place sites on the NPL. NSP has evaluated the following HRS factors relative to the NV site, although the NV site was assessed (scored) together with the BV site.

4.1 Sources of Contamination

Prior to ERS reclamation, the NV claim open-pit mine and associated mine tailings were sources of contamination [2]. Presently, the DOE claim's unreclamated mine adit and tailings are sources of contamination. Tailings material is suspected of generating leachate composed of radiometric species which migrates with runoff [2].Radioactive particulates are blown off the tailings piles [2]. The estimated total volume of tailings reclamated on the NV claim was 52,600 yd³ (158,105 ft 3 [2]. The unreclamated DOE claim has about 68,370 yd³ of mine tailings [2]. The mine adit on the DOE claim is potentially emitting significant radon gas levels [2]. ERS reclamation has negated the NV claim sources of contamination [3].

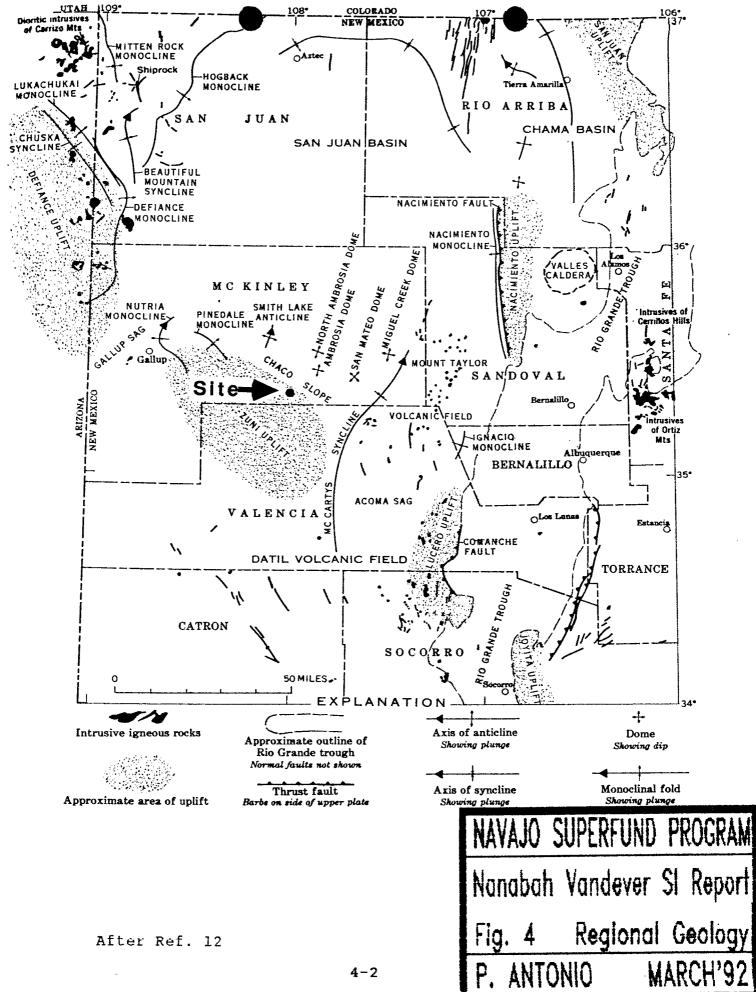
4.2 Groundwater Pathway

4.2.1 Hydrogeologic Setting. Regionally, the site is on the southern Chaco Slope within the Colorado Plateau physiographic province [12]. The site is bounded on the north by the San Juan Basin and on the south by the Zuni Uplift [12; Fig. 4]. Area stratigraphy consists of several thousand feet of consolidated sedimentary rocks sloping 3-10° N-NE into the San Juan Basin, with associated intrusive and extrusive rocks of the Mt. Taylor volcanic field [12].

The site is on the Todilto Limestone (LS) composed of very fine-to medium-grained LS with some shale and sandstone (SS) [12]. Mineable ore reserves were in the Todilto LS [6]. Subsequent descending strata are the Entrada SS, the Chinle Formation with the basal Shinarump Conglomerate, and the San Andres LS/Glorieta SS [12]. Developed area aquifers are the Entrada SS, the Sonsela SS of the Chinle Formation, and the San Andres LS/Glorieta SS [13]. Groundwater on-site is estimated at 140 feet below surface, derived by projecting updip from a nearby well. Aquifers are recharged by infiltration at outcrops south of the site. Area groundwater flows in a N-NE direction, corresponding to the dip of bedrock [2].

Additionally, mine declines and exploratory drillholes descended possibly to depths of 200 feet [2].

4.2.2 Groundwater Targets. The nearest public water supply (PWS)



4-2

if you from N-NE

well (#16T-551) is located downgradient 1 mile SE of the site in the Sonsela aquifer and serves about 430 people [13]. The PWS well has a static water level of 417 feet below surface [13]. There are 4 other wells, all used for livestock, within 1.5 miles of the BV site [13]. There is a possibility of human cosumption of water from the livestock wells due to lack of PWS availability [2]. One livestock well (Pre-school) has been shown to be above drinking water standards [11].

4.2.3 Groundwater Pathway Conclusion. Four out of the five wells near the NV site show no contamination [10]. The Pre-school well has a gross alpha level just above the MCL; however, it is difficult to attribute the increased gross alpha level to the NV site. This also indicates the declines and exploratory drillholes are not efficient conduits for groundwater contaminant migration, predominantly due to poor conductivity of the Todilto LS. With this in mind, there is apparently very little potential for contaminant migration from the NV site to area groundwater.

4.3 Surface Water Pathway

- Hydrologic Setting. NV on-site runoff flows westward in 4.3.1 minor drainages before all spill into an ephemeral stream near the DOE claim's mine [5]. From the DOE claim, the stream runs SE for over a mile before terminating into the surrounding valley floor [5]. The NV site physical soil profile consists of light colored soils dominated by Torriorthents and Haplargids groups with rock outcrops [14]. These soils are dry/salty and are principally derived from SS, shale and LS [14]. Such soils are present on gently sloping and undulating landscapes, also on steeply sloping and rolling ridges [14]. The texture of this soil category ranges from sandy loam to heavy clay loam [14]. Soil depth is 0-40 inches [14]. The 2-year, 24-hour rainfall in the site vicinity is 1.2-1.4 inches [2]. The site's annual net precipitation is about minus 44 inches [2]. The site is not in a 100-year floodplain but the area is prone to severe thunderstorms and flash flooding [2].
- 4.3.2 Surface Water Targets. There are no drinking-water intakes, irrigation, industrial, or recreational uses of surface water within the entire 5-mile drainage length [2,5]. Homes are located about 250 yards downgradient from the DOE claim's tailings piles next to the ephemeral stream. Area livestock are known to drink accumulated surface water in earthen stock ponds located throughout the drainage length [2]. There apparently is no critical habitat for federally designated threatened or endangered species within the downdrainage area of concern [2].
- 4.3.3 Surface Water Pathway Conclusion. The only significant target involves livestock consumption of ponded surface water. The analytical results of a downdrainage soil sample indicates some

contaminant transport [10--Sample 3A]. Despite the exposed DOE claim tailings material, potential for human exposure via this pathway is very low.

4.4 Soil Exposure and Air Pathways

4.4.1 Physical Conditions. Pre-reclamation NV claim conditions, like present DOE claim conditions, had the site readily accessible with no recreational use, sparse vegetation of native grasses and shrubs, and roads present through the site [2]. About 18 acres of the NV claim required reclamation due to surface contamination sourced from an open-pit mine and associated mine tailings [1,2]. The unreclamated DOE claim has about 68,370 yd of mine tailings covering about 14,200 ft of surface area. The NV site has elevated concentrations of radium and uranium detected in on-site soils, waist level radiation levels ranged from 20-750 microRoentgen per hour (uR/hr), and significant radon-flux emissions attributable to the tailings [1]. There was also a good potential for the transport of radioactive particulates because of the fine-grained nature of the tailings material, the lack of containment, and the semi-arid, windy climate of the region [2].

Post-reclamation conditions have the NV claim still accessible but with posted warning signs, revegatated with native grasses, and all roads reclaimed [1]. The 3-4 feet of cover placed on the NV claim reclamated areas has radioactivity below applicable radiological standards [3]. However, the unreclamated DOE claim mine tailings is likely migrating downgradient toward the residences located about about 250 yards downstream of the tailings [10--Sample 3A].

- 4.4.2 Soil and Air Targets. The on-site population consists of about 3-10 workers comprised of sheepherders [2]. About 12 people reside within 200 feet of observed contamination, signified by gamma radiation more than twice background level (11 uR/hr). There are also more than 40 people living within 0.25 miles of the site and some 630 people residing within 4 miles of the site [1,2]. Children often play on the NV site [2]. Livestock are known to graze throughout the site [2]. There are no threatened or endangered species known to be habitating in areas that were contaminated [2].
- 4.4.3 Soil Exposure and Air Pathways Conclusions. The reclamated cover on the NV claim has apparently sharply lowered the potential for exposure via these particular pathways. However, the unreclamated DOE claim has an apparent high potential for exposure, especially to the 12 or so people residing downgradient from the DOE claim's mine tailings.

5.0 EMERGENCY RESPONSE CONSIDERATIONS

The National Contingency Plan [40 Code of the Federal Register 300.415(c)(2)] authorizes the Environmental Protection Agency (EPA) to consider emergency response actions at those sites which pose an imminent threat to human health or the environment.

In pre-reclamation conditions, emergency response by EPA Region 9 was deemed appropriate at the NV claim for the following reasons: the site was readily accessible and uncontained, allowing the following hazards to exist; the open pits and declines posed a significant physical hazard to the neighboring populations; any heavy metals associated with the weathering mine tailings seemed to pose a significant environmental and health hazard; and, elevated concentrations of radioactive material within the tailing piles were likely migrating and may have exposed the neighboring population to unsafe levels of radiation [1].

There is no apparent need for emergency response for the NV site at this time because the reclamation action undertaken by EPA and SFRP has significantly reduced the radiological hazards associated with gamma radiation and radionuclide concentrations [3]. ATSDR has indicated that removal actions on the NV claim were satisfactory and protective of public health [1]. The DOE claim will be addressed by DOE, and its current lessee [8].

6.0 SUMMARY

The Nanabah Vandever (NV) abandoned uranium/vanadium mines site is 4 miles east of Prewitt, New Mexico in eastern McKinley County, next to the Haystack Butte (SE1/4, SE1/4, Sec. 13 and NE1/4, NE1/4, Sec. 24 of Township 13 N, Range 11 W, NM Meridian). Section 13 contains the Department of Energy claim (NM-B-1 lease) and Section 24 contains the NV claim. The NV claim was operated during 1952-57 by Glen Williams, Santa Fe Uranium, and Federal Uranium Corporation. The DOE claim was operated during 1958-61 by the Haystack Mountain Development Corporation and during 1975-81 by the Todilto Exploration and Development Corporation, who still holds an active lease to the DOE claim. No formal reclamation program was instituted after mining ceased on the NV claim and most of the DOE claim.

Over the NV siter's operational history, ore with insufficient uranium quantities were discarded on-site. An estimated total volume of 52,600 cubic yards of mine tailings was reclamated by EPA on the NV claim. About 68,370 cubic yards of unreclamated mine tailings exist on the DOE claim. The tailings material is a radiological hazard due to elevated emissions of gamma radiation, significant radium concentration, and radon-flux. Mine tailings material is suspected of migrating by surface runoff. Particulate matter is being blown off the mine tailings piles. Recent EPA reclamation on the NV claim has diminished the risks associated with mine tailings contamination, but not on the DOE claim.

The NV mines site was combined and scored under the Hazard Ranking System with the adjacent Brown Vandever mines site. The following are significant Hazard Ranking System factors associated the NV mines site after recent EPA reclamation, excluding the Brown Vandever mines site:

- O Documented release to surface soils for the DOE claim;
- O High waste quantity for the DOE claim;
- Low potential for a documented release to groundwater, air, and soil;
- About 12 people reside within 200 feet of an area of contamination, 40 people reside within 0.25 miles of the site and 3-10 people herd sheep on-site; and,
- Recent EPA reclamation negated both an observed release to soil and a high waste quantity on the NV claim.

The Navajo Superfund Program was the predominant tribal office involved with this site. The Department of Energy will attempt to work with their lessee to perform reclamation on Section 13.

7.0 EPA RECOMMENDATIONS

U.S. EPA

No Further Remedial Action Planned Under CERCLA Higher-Priority LSI under CERCLA	Pal	12.10.92
Lower-Priority LSI under CERCLA	Manuali Antilo A	Marie Communication or Communication of
Defer to Other Authority (e.g., RCRA, TSCA, NRC)	Maria Caracteria de Caracteria	Laurenten geringsper

Initial Date

Post-ER Action radiation lavels are protective of human health & the environment

8.0 REFERENCES

- 1. U.S. EPA, "Federal On-Scene-Coordinator's Report: Bluewater Uranium Mine Sites," prepared by Robert Bornstein, Region 9, October 29, 1991.
- Navajo Superfund Program, "Preliminary Assessment of Nanabah Vandever Uranium Mine," prepared by Thomas Morris, June 6, 1990.
- 3. Bornstein, Robert, U.S. EPA ERS, Region 9, to Bluewater Interagency Committee, memorandum re: post removal soil data for Bluewater Uranium Mine Sites, December 23, 1991.
- 4. Hanks, Herrick E., Bureau of Land Management, Rio Puerco Resources Area, to Louise Linkin, Navajo EPA, letter re: radon gas in Navajo homes, July 7, 1988.
- 5. U.S. Geological Survey, map of Bluewater, New Mexico, 7.5 Quadrangle, 1957.
- 6. McLemore, Virginia T., <u>Uranium and Thorium Occurrences in New Mexico: Distribution, Geology, Production, and Resources, with Selected Bibliography</u>, New Mexico Bureau of Mines and Mineral Resources, Open-file Report 183, September 1983.
- 7. Agency for Toxic Substances and Disease Registry, "Public Health Advisory: Navajo-Brown Vandever and Navajo-Desiderio Uranium Mining Areas, Navajo Nation, Bluewater, New Mexico," November 21, 1990.
- 8. Ivey, Robert E., Department of Energy, to Robert Bornstein, U.S. EPA Region 9 ERS, letter re: "Action Memorandum" by EPA, June 21, 1991.
- 9. U.S. EPA, "Preliminary Assessment Workplan: Navajo-Brown Vandever and Navajo-Desiderio Uranium Mining Areas, Navajo Nation, Bluewater, New Mexico," prepared by Robert Bornstein, Region 9, November 9, 1990.
- 10. Bornstein, Robert, U.S. EPA ERS, Region 9, to Gaurav Rajen, Navajo Superfund Program, letter re: Bluewater Uranium Mine preliminary assessment data, January 29, 1991.
- 11. Dowell, Charles, Indian Health Service, Navajo Area, to Rosita Loretta, Baca Chapter House, letter re: pre-school well water sample data, May 9, 1991.

REFERENCES (cont.)

- 12. Hilpert, Lowell, <u>Uranium Resources of Northwestern New Mexico</u>, U.S. Geological Survey, Professional Paper 603, Washington, D.C.: GPO, 1969.
- 13. Navajo Office of Water Development, "Well Records for Wells #16T-551, #16T-552, #16T-521, #16T-586, and #16B-38." Ft. Defiance, Arizona, 1960.
- 14. Roybal, F.E., et al., <u>Hydrology of Area 62</u>, <u>Northern Great Plains and Rocky Mountain Coal Provinces</u>, <u>New Mexico and Arizona</u>, U.S. Geological Survey, Water-Resources Investigations, Open-file Report 83-698, Albuquerque, NM, 1984.

APPENDIX A

PHOTODOCUMENTATION



DESCRIPTION:

"A" is reclamated NV Claim in Sec. 24. "B" is unreclamated DOE Claim NM-B-1 (Todilto Exp. & Dev. Corp.) in Sec. 13. "C" is previously reclamated DOE Claim in Sec. 13. Arrow in foreground points to open ventilation and bore holes in Sec. 13. Homes can be seen just left of "B" past the sandstone outcrop. The road in the background goes right to Prewitt, NM.

DATE: Nov. 91

TIME: 12:45 PM

DIRECTION:

S-SE

WEATHER:

Sunny

PHOTOGRAPH BY:

P. Antonio

DATE: Aug. 91

TIME: PM

DIRECTION:

N-NE

WEATHER:

Sumy

PHOTOGRAPH BY:

R. Bornstein

DESCRIPTION:

Photo of earthmoving reclamation at NV Claim.

DATE: Aug. 91

TIME: PM

DIRECTION:

M - MM

WEATHER:

Overcast

PHOTOGRAPH BY:

R. Bornstein

DESCRIPTION:



Eartmoving reclamation again at the NV Claim. All three of the dozers used in the reclamation are in action in the above photo.

DATE: Nov. 91

TIME: 11:00 AM

DIRECTION:

N-NE

WEATHER:

Sunny

PHOTOGRAPH BY:

P. Antonio

DESCRIPTION:



Residences located downgradient from unreclaimed DOE Claim. The gray tailings are to the left of the homes.

DATE: Nov. 91

TIME: 12:30 PM

DIRECTION:

West

WEATHER:

<u>Summy</u>

PHOTOGRAPH BY:

P. Antonio

DESCRIPTION:



Warning signs left on the reclamated NV Claim, also on the BV and HS Claims. Written in English, Navajo, and Spanish.

DATE: Nov. 91

TIME: 1:15 PM

DIRECTION:

<u>W-SW</u>

WEATHER:

Sunny

PHOTOGRAPH BY:

P. Antonio

DESCRIPTION:

Photo of unreclamated DOE Claim. Arrow points to mine deline.

DATE: Nov. 91

TIME: 12:30 PM

DIRECTION:

West

WEATHER:

Sunny

PHOTOGRAPH BY:

P. Antonio

DESCRIPTION:

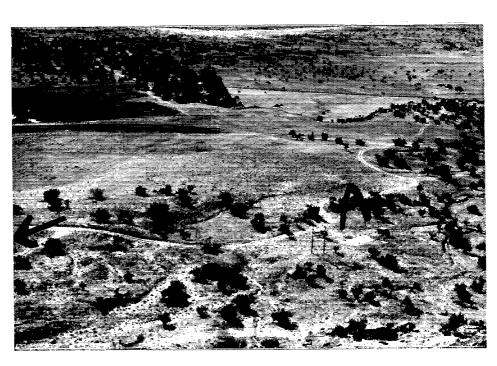


Photo of a portion of DOE Claim. "A" is site of open ventilation shaft. Arrow points toward open borehole emitting high radon.

Postlamation reclamation soil data

MANAGO SUPERIUM PROGRAME Mandrah Vandever Si Report Reference 3 P. ANTONIO MARCH'92



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street San Francisco, Ca. 94105-3901

December 23, 1991

MEMORANDUM

SUBJECT: Post Removal Soil Data, Bluewater Uranium Mine Sites

FROM:

Robert Bornstein

Federal On-Scene-Coordinator

TO:

Bluewater Interagency Committee

Enclosed for your review are the post removal soil sampling data collected at the Bluewater Uranium Mine Sites. During the week of September 15, 1991, ten composite samples were collected from the Bluewater Uranium Mine Sites. The composite samples were analyzed for Uranium isotopes and Radium 226 at the USEPA National Air and Radiation Environmental Lab located in Montgomery, Alabama.

BROWN-VANDEVER-NANABAH: Section 24, T13N, R11W

In order to collect the composite samples, the reclamated zone was subdivided into three areas: BV24A, BV24B, BV24C. Using a 45'X 50' grid (total 45 samples per section), samplers collected five tablespoon surface samples along the grid and placed them into a mixing bucket. After completing the sampling, the bucket was thoroughly mixed and a composite sample of one kilogram was collected and transferred into a zip lock bag. A background composite sample, BV24D, was collected by selecting 45 random samples from undisturbed portions of Section 24. See figure A.

BROWN-VANDEVER: Section 18, T13N, R10W

Two samples were collected within Section 18. A total of 45 samples were collected within the reclamated area. These samples were well mixed and a 1 Kg composit sample was drawn (BV18A). In addition, a random composite background sample was collected along the perimeter of the reclamated area in undisturbed areas (BV18B). See figure B.

DESIDERIO MINE SITE: Section 26, T 13N, R 10W

The Desiderio Mine Site area was subdivided into three equal sections. A 45'X 100'grid (total of 45 samples per section) was used to collect five tablespoon surface samples. The samples

were placed into mixing bucket and a 1 Kg smposite sample was withdrawn. A random composite background sample was collected from non-disturbed areas around Section 26. See figure C.

DISCUSSION

The soil sampling data reveals that the reclamation action has successfully reduced any potential surface radiological hazard at these sites. The data shows that background conditions within the mine sites are not significantly lower than those detected within the reclamated areas. No sample exceeded the regulatory standard of 5 pCi/g over background pursuant to 40 CFR Section 192.

In general, the Radium 226 levels recorded within the reclamated zones are not uncommon to the natural Radium 226 concentrations detected within the Grants Mining District. Background Radium 226 concentrations in Milan, New Mexico (approximately 15 miles SE of the sites) have been reported by the Office of Radiation Programs (1) to be as high as 6.2 pCi/g. Background concentrations of Radium 226 of 2.2 pCi/g and 3.3 pCi/g were detected outside of San Mateo, New Mexico and within unmined areas of Ambrosia Lake.

Attached for your review is a copy of the Risk Assessment data generated by Steve Dean, Office of Air and Radiation, using sample BV24A. This sample was selected since it recorded the highest uranium and radium 226 content. The Assessment took into account all four possible pathways from soil exposure; ingestion, particulate inhalation, volatiles, and external gamma. The exposure scenario of eight (8) hours per day, 50 weeks per year for one year was used. Based on this scenario and a sample concentration of total uranium at 7.0 pCi/g and Radium 226 at 3.7 pCi/g (these samples include their respective background), the combined total risk from both metals for this sample is 3.0 in 10 million (3.0 X 10 -7). Using a Superfund residence scenario of thirty years, the total risk factor is 9 in 1 million excess cancer risk (9.0 X 10 -6).

Overall, the risk factor for the other samples are well below these figures. This risk calculation is a worst case scenario using the highest sample data. Risk associated with the natural conditions documented in the OAR Report (1) are also within the same risk factor or greater than those calculated for the BV24A sample. EPA uses the 10⁻⁶ risk value as a "point of departure" when selecting clean-up levels for National Priorities List Sites (40 CFR Section 300.430).

[&]quot;Report of Ambient Outdoor Radon and Indoor Radon Progeny Concentrations During November 1975 At Selected Locations in the Grants Mineral Belt, New Mexico," Office of Radiation Programs, Las Vegas, NV., June 1976, Report # OAR/LV-76-4: USDC NTIS PB-258-257.

CONCLUSIONS

In conclusion, the reclamation action undertaken by EPA has significantly reduced the radiological hazards associated with the mining wastes at the Bluewater Uranium Mine Sites. Both gamma radiation and radionuclide concentrations at the sites have been reduced to "natural" or background conditions. As documented in the OAR report referenced above, it is not uncommon to find natural Radium 226 readings higher within the Grants Mining District than those detected within our samples. The EPA response team to Bluewater believes that these sites no longer pose any immediate health hazard to the local public or wildlife. As a safeguard, further radiological testing and monitoring should be performed prior to any residential structures being constructed on the Sites.

If you have any questions or concerns, please contact me at 415-744-2298 (FTS 484-2298).



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION IX

75 Hawthorne Street San Francisco, Ca. 94105-3901

December 20, 1991

MEMORANDUM

SUBJECT: Bluewater Uranium Mine Site Soil Samples Data

FROM:

Steve M. Dean

Environmental Scientist, (A-1-1)

TO:

Robert Bornstein

Environmental Scientist, (H-8-3)

Listed below are the total uranium and radium 226 results for the 10 composite soil samples collected from the Bluewater Uranium Mine Site. The values listed are in picoCuries per gram (pCi/g) for dry weight of soil:

SAMPLE ID	Total Uranium	Radium 226	
BV24A	7.0	3.7	
BV24B	3.6	3.2	
BV24C	3.2	2.9	
BV24D (Background)	0.55/0.64*	0.73/0.90*	
BV18A	1.5	0.94	
BV18B (Background)	0.97	0.93	
DES1	2.9	1.8	
DES2	3.5	3.6	
DES3	2.3	1.7	
DES4 (Background)	2.2	2.4	

^{*} Analysed twice as a duplicate sample.

Since Sample BV24A was the highest in uranium and radium 226, I used its concentrations to perform a soil exposure risk assessment using Superfund's Risk Assessment Guidance, Human Health Evaluation Manual Part B. This assessment took into account all four possible pathways from soil exposure; ingestion, particulate inhalation, volatiles, and external gamma. I also used an exposure scenario of 8 hours per day, 50 weeks per year for one year. Based on the above concentrations and this scenario, the total risk for uranium is 1.6

in 10 million and total risk for radium 226 is 1.4 in 10 million. Combined total risk from both metals at this location, (BV24A), is 3.0 in 10 million.

I hope this information is useful to you, if you have any questions or need any further assistance please contact me at X4-1049. Thank you.

Attachments

cc: Mike Bandrowski, (A-1-1)

RADIONUCLIDE OF CONCERN? u23 SAMPLE BV24 A.
ENTER THE INGESTION SLOPE FACTOR? 1.4E-10
NOW ENTER THE INHALATION SLOPE FACTOR? 2.7E-8
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 5.7E-14
ENTER RADIONUCLIDE CONCENTRATION (in pci/gram)? 3.385
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 4.730863E-12
VOLATILE RISK = 1.892345E-27
PARTICULATES RISK = 3.639125E-14
EXTERNAL EXPOSURE RISK = 1.804036E-08
TOTAL RISK = 1.804513E-08

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

RADIONUCLIDE OF CONCERN? U235
ENTER THE INGESTION SLOPE FACTOR? 1.3E-10
NOW ENTER THE INHALATION SLOPE FACTOR? 2.5E-8
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 9.6E-12
ENTER RADIONUCLIDE CONCENTRATION (in pci/gram)? .1388
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 3.267138E-11
VOLATILE RISK = 1.306855E-26
PARTICULATES RISK = 2.513183E-13
EXTERNAL EXPOSURE RISK = 1.245869E-07
TOTAL RISK = 1.246198E-07

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

RADIONUCLIDE OF CONCERN? U238

ENTER THE INGESTION SLOPE FACTOR? 1.3E-10

NOW ENTER THE INHALATION SLOPE FACTOR? 2.4E-8

ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 4.6E-14

ENTER RADIONUCLIDE CONCENTRATION (in pci/gram)? 3.524

NUMBER OF HOURS PER DAY OF EXPOSURE? 8

ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50

ENTER NUMBER OF YEARS OF EXPOSURE? 1

INGESTION RISK = 3.974666E-12

VOLATILE RISK = 1.589866E-27

PARTICULATES RISK = 3.057435E-14

EXTERNAL EXPOSURE RISK = 1.515672E-08

TOTAL RISK = 1.516073E-08

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

RADIONUCLIDE OF CONCERN? RA226
ENTER THE INGESTION SLOPE FACTOR? 1.2e-10
NOW ENTER THE INHALATION SLOPE FACTOR? 3e-9
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 4.2e-13
ENTER RADIONUCLIDE CONCENTRATION (in pci/gram)? 3.7
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 3.810288E-11
VOLATILE RISK = 1.524116E-26
PARTICULATES RISK = 2.930991E-13
EXTERNAL EXPOSURE RISK = 1.45299E-07
TOTAL RISK = 1.453374E-07

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

*** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:25 by CRIKNG.

Sample Id:		RSE	91.07507	BUZHA		
Counting sy	stem	AS 1	- Shelf A	Prep Date	11/26/9	1
Date, Time	counted	11/2	7/91 14105	Bkg Date	11/22/9	1
Type Analys		U pr	ep by AS	Eff Date	12/19/9	0
Length of c	ount	1000	.0 Min	Std Date	10/09/9	1
Detector ef	ficiency	0.21	3			
Sample size		0.52	01 GASH			
Factor # 1		0.93	70 GWET			·
Factor # 2		0.98	20 GDRY			
**					2 21	gma error
Gross chts:	Isotope	8kg	PC1/GASH	MDA	in %	Absolute
U-234	504	_				
U-234	884.	6.	3.447E+00	5,535E=02	11,34%	3.909E=01
U-238	36.	0.	1.413E-01	1.064E=02	34.55%	4.883E=02
04238	917.	3,	3,5882+00	4.226E-02	11.25%	4.035E-01
	न्य	Mu	7.2		0 04	
Gross chts:	Tentone	Bka	PC1/GWET	MDA		gma error
•	rectore	w/.~	ECT/ Gati	una	in *	Absolute
U-234	884.	6.	3.230E+00	5.535E-02	11.34%	3.662E-01
U-235	36.	Ö.	1.324E-01	1.064E-02	34.554	4.575E=02
U-238	917.	3,	3.362E+00	4.226E=02	11.25%	3.781E-01
	•			, , , , , , , , , , , , , , , , , , ,		## 1070-07
•	יסד	tal u	l 6.7		2 51	oma error
Gross cnts:	Isotope	RKG	PCI/GDRY	ADM	in %	Absolute
U-234	884.	6.	3.385E+00	5.535E=02	11.34%	3.838E-01
U=235	36.	Ö.	1.388E-01	1.064E-02	34.554	4.795E-02
U-238	917.	3.	3.524E+00	4.226E-02	11,25%	3.963E=01
	70	STALL	7.0			
				********	*****	********
****			and Written :		*****	•
- 全主主众主义文字文字 4 7	4.业未本本本本等年期;	*****	**********	***********	******	*******

12/11/1991 14:23 MAREL MONT. ALA.

This listing was greated 12/03/91 at 08:26 by CRIKNG.

Sample Id:	R95 9	1.07508	BY248		
Counting system Date, Time counted	11/27	- Shelf A 1/91 14:05	Prep Date Bkg Date	11/26/91 11/22/91	
Type Analysis		p by As	Eff Date	12/19/90	
Length of count		o Min	Std Date	10/09/91	
Detector efficiency	0.306				
Sample size		5 GASH			
Fector # 1	•	O GWET		٠	
Factor # 2	0.95	IQ GDRY			
Managa and a fine	•		* * *	2 5ig	ma error
Gross ents: Isotope	FKQ	PCI/GASH	ADA	in %	Absolute
U-234 424.	5,	1,879E+00	5.878g-02	13,63%	2.560E-01
U-235 17.	1,	7.175E-02	3.300E-02	53.86%	3.864E=02
U-238 406.	4.	1.803E+00	5.385E-02	13.76%	2.481E-01
•	TOTALL	_ ·			-1401m-01
	•	•		2 5ig	ma error
Gross ents: Isotope	Bkq	PC1/GWET	MDA	in %	Absolute
U-234 424.	5.	1.772E+00	5.878E-02	13,634	2.414E-01
U-235 17.	1.	6.766E-02	3,300E-02	53,86%	3.644E-02
U+238 406.	4.	1.700E+00 ·	5,385E-02	13.76%	2.340E-01
•	TOTALI	4 3.5		2 810	
Gress ents: Isotope	Bkq	PC1/GDRY	MDA	in 4	ma error Absolute
U-234 424.	5.	1.792E+00	5.878E+02	13.634	2.443E-01
U-235 17.	1.	6.845E=02	3.300E-02	53.86%	3.686E-02
U-238 406.	4.	1.720E+00	5.385E-02	13.76%	2.367E-01
,	TETAL				210010-01
**********	10101	, , , , , , , , , , , , , , , , , , , 			
****** Recald	rrrere Blated	and Written	ttatttatttät To Database	******	******

12/11/1991 14:23 A NAREL MONT. ALA.

This listing was created 12/04/91 at 07:46 by CRIKNG.

		. •				
Sample Id:	•	R95 9	1.07509	BV24C		
Counting sy			- Shelf A	Prep Date	11/26/9	1
Date, Time	counted	12/02	/91 14:05	Bkg Date	11/22/9	
Type Analys:		U pre	p by AS	Eff Date	12/19/9	
Length of co	ount	1000.	0 Min	Std Date	10/09/9	~
Detector ef	ficiency	0.213	}			
Sample size	· · · · · · · · · · · · · · · · · · ·	0.517	O GASH			
factor # 1		0.955	8 GWET			
Factor # 2		0.988	O GDRY			
					2 81	gma error
Gross cnts:	Isotope	Bkg	PCI/GASH	MDA	in %	Absolute
U-234	375.	5.	1.566E+00	5.549E-02	14,01%	-2.194E-01
U-235	19.	0.	8.043E-02	1.147E-02	46,80%	3.764E-02
U-238	375.	2.	1.579E+00	3.931E=02	13,924	2,197E-01
	·	TOTALL	7.7			
		Laurer	J. C		2 51	gma error
Gross cots:	Isotope	Bkq	PC1/GWET	MDA	in %	Absolute
Ü-234	375.	5.	1,497E+00	5.549E-02	14,01%	2.097E-01
U-235	19.	0.	7.688E-02	1.147E-02	46.80%	3,5985-02
U-238	375.	2.	1.509E+00	3,931E=02	13.92%	2.100E-01
	•	TORLU	3.(2 51	cma error
Gross cnts:	Isotope	Aka	PCI/GDRY	MDA	1n %	Absolute
U-234	375.	5.	1.547E+00	5.549E-02	14,01%	2.1682-01
U-235	19.	Ö.	7.947€-02	1,147E=02	46.80%	3,719E-02
U-236	375.	2.	1.560E+00	3,931E-02	13,92%	2.171E=01
		TOTAL U	3.2	•		
********	******	*****	********	**********	******	*******
******	Recald	tulated	and Writter	n To Database	*****	*

14:24 MONT. BLA.

*** usa matore from Calculations from Program Asu ***

This listing was created 12/03/91 at 08:29 by CRIKNG.

24	A 315AB - A BA	sounting system
BASHD	01270.19 88#	ipi əlduğç

Prep Date Brg Date Ext Date	As 4 - shelf A 11/27/91 14:05 U prep by As	conting system 'ounted' Time counted'.
G 2 44 4 C	A. A	

0.9560 GWET 0.5073 GASH 0.236 1000°0 WIU

0.9800 GDRY

retector efficiency

azis aldur

sength of count

etavianh aqv.

4010#. 1 # 10738.

U-234 toss chtes laotope BKO

SCINCHEL BKu tota cufe: Itotobe 950 MINUL * 14 • 0 3.719E-01

3.

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* # 5

LOWEL DISS 3.599E-01 -0-* 54 3'ee1E-03 =<WDY 3'22EE-05 3 . 3.

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BKC

tosa duras Isotope

0-238

1-332

1-234

U-238.

252-0

* 3 4 862-0 * E 0-235 . 16 * 0Z U-234

SPO KIWEL

********************* Recalculated and Written To Database **** *************************

S'0-3599'Z

10-3777 5

PCI/GDRY

3.709E-01

Z.834E-01

PCIVGASH

52.29

30"12#

& 43

52'58#

\$0E. 733

30"12#

& UI

32'58#

30'12#

a ur

16/60/01

13/110/00

11/55/61

16/92/11

\$0E. TAA

1 038E-05

9.001E-02

YOW

1.038E-02

8 001E-05

YOW

1.038E-02

9.001E-02

MDY

sta bata

3°123E-03 =< NDV .3'826E-05. 441'30#

20-3664'9

1.679E-02

8.373E-02

Absolute

20-3+45.9

1.638E-02

8.158E-02

Absolute

6.877E+02

1.713E-02

8.544E-02

Absolute

2 Signa error

2 Signa error

Z Sidma error

SYIND

:

SS8 3424

3'836E-03 =< HDY 3'RREE-05

15/11/1881

This listing was created 17/03/91 at 08:29 by CRIKNG.

d anala ***				.	.1 1		
sample Id:	•	#95 9	91.07510X	BV2	An .		
Counting sys		A\$ 5	- Shelf A		Prep Date	11/26/91	
Date, Time c		11/27	7/91 14:05		Bkg Date	11/22/91	
Type Analysi			ep by As		Eff Date	12/19/90)
Length of co			O Min		Std Date	10/09/91	
Detector eff	iciency	0.206					
Sample size			4 GASH				
Factor # 1			50 GWET		1		
Factor # 2		0.980	O CDKY			•	
						2 810	ima error
Gross chts:	Tsotope	BKQ	PCI/GASH		MDA	in t	Absolute
U-234	62.	7.	2.460E-01		6.714E-02	31.64%	7.781E-02
U=235	1.	0.		#CHDA	1.212E-02	200.22%	
U=238	91.	1,	'4.025E-01		3.291E=02	23,30%	9.377E-02
	-10	MLW	0.65			-	•
	•						ing error
Gross chts:	Isotope	BKq	PCI/GWET		MDA	in 🗣	Absolute
U-234	62.	7.	2.351E=01		6.714E-02	31,64%	7.439E-02
U=235	1.	0.	4.275E=03	= < MDA		200.22%	8.560E-03
U=238	91.	1.	3.848E-01		3.291E-02	23.30%	8.964E-02
	10	MLK	8.62			ש מל מ	me error
Gross cots: 1	sotape	BKa	PC1/GDRY		NDA	1n &	Absolute
U-234	62,	7.	2.4104-01		6.714E=02	31,64%	7.626E-02
U=235	1.	0.	4.383E-03	= CHDA	1.212E-02	200.22%	8.775E-03
U-238	91.	1.	3.944E-01		3,291E-02	23.30%	9.1898-02
	-71	MALN	0.64				
	• •						

************************ Recalculated and Written To Database ************************

*** MANUAL Urenium Celculations from Program Asu ***

- This listing was created 12/04/91 at 07:47 by CRIKNG.

Sample Id:	R98 91.07511	BYISA		
Counting system Date, Time counted Type Analysis Langth of count Detector efficiency Sample size Factor # 1 Fector # 2	AS 2 - Shelf A 12/02/91 14:05 U prep by AS 1000.0 Hin 0.206 0.5130 GASH 0.9730 GWET 0.9958 GDRY	Prep Bkg Eff	Date Date Date Date	11/26/91 11/22/91 12/19/90 10/09/91

Chan		•		·· · • • • •		
	s: Isotope	BKq	PCI/GASH	NDA	2 8	gma error
U+234 U+235	180.	4,	7.534E-01	·	in a	Absolute
U-238	13. 158.	0.	5.565E=02	5.141E=02 1.160E=02	18.013	1.357E-01
_	•	3. PATHLX	6.635E-01	4.608E-02	56,25% 18,84%	3.130E-02 1.250E-01
Gross cots	: Isotope	ākq	PCI/GWET	MDA	2 51	gme error
U-234	180.	4.	7 2350 4	MUA	in 4	Absolute
U-235 U-238	13. 158.	0.	7.330E-01 5.414E-02 6.456E-01	5.141E-02 1.160E-02	18.014	1.320E-01
_	7	OTHLU	14	4,608E-02	18,844	3.046E-02 1.216E-01
Fross ents	Isotope	Bkg	PCI/GDRY	Au Ma	2 819	ima error
U-234	180.	4.		MDA	in a	Absolute
V=235 V=238	13. 158.	v.	7.502E-01 5.541E-02	5.141E=U2 1.160E=02	18.014	1.351E=01
	_		6.607E-01 1.5	4.608E-02	56,25% 18.84%	3.117E=02 1.245E=01
******	*******	****	• • •			_

12/11/1991 14:26 ANAREL MONT. ALA. * ** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:30 by CRIKNG.

Sample Id:	•	R95 9	1.07512	BUIRE	S		
Counting sy			- Shelf A		Prep Date	11/26/91	
Date, Time		11/27	/91 14:03	5	BKQ Date		
Type Analys:			p by As		Eff Date		
Length of co		1000.0	0 Min		Std Date	10/09/91	1
Detector ef	ficiency	0.211					6
Sample size			4 GASH				0
Factor # 1			D GWET		•		
Factor # 2		0.984	O GDRY				
	•					2.519	me error
Gross ents:	Isotope	Bkq	PCI/GAE	5H	NDA	4n 4	Absolute
U-234	113.	5.	5.042E=0)1	6.1198-02	, 22,22%	1.120E-01
U=235	2.	2.	0,000E+0	AGM>= OC	4.335E-02	0.00%	1.867E-02
U-238	104.	1.	4.908E-() 1	3.436E=02	22.02%	1.059E-01
	77	BTHLU	0.98			• • •	
C		.				-	ma error
Gross chts:	Trofohe	BKG	BCI\CAF	r. T	MDA	in %	Absolute
U-234	143.	5.	4.810E-0) 1	6.119E-02	22,22%	1.069E=01
U-235	2 .	2.			4.3358-02	0.00%	1.781E-02
U-238	104.	1.	4.587E-0		3.436E-02	22.02%	1.0102-01
	•	TOTALL	A .		-	- •	·
•			•				TOTIS AME
Gross ents:	Isotope	Bkg	PCI/GDF	Y	MDA	in 4	Absolute
U-234	113.	5.	4.961E=0) 1	6.119E-02	22,22%	1.102E=01
U-235	2,	2,			4.335E-02	0.00%	1.837E-02
U-238	104.	1.	4.731E-0	1	3.436E-02	22.02%	1.042E=01
	-		602				
	_	TOTALL	0.97				

Recalculated and Written To Database

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			P.2 N. JAT	of .	
	* = . * =				
10-3638.1	13,384	1.077E-02	0° 1°385E+00		U-238
3.179E-02	\$9L.88	3°661E-05	S' 2'410E-05		n*532
1.925E-01	13,444	6,622E+02	9. 1.432E+00	*907	N-234
Abrolute	a uş	AGM	KG BCT\CDB1	e adolosi	toss cuts:
てひててき 本市以	2 87				
			8.5 Km	TOT	
1.8255-01	13,384	1.0775-02	0° 1'384E+00		N-238
3.115E-02	196.85	3 691E-02	S' 2'301E-05		n~532
1.886E-01	****	6.622E-02	9. 1.403E+00	•90	n=534
Absolute	a uş	AGM	KO BCINCMEL	isorope B	TORE CUERT
gra error	3 8T			_	
			2.E K.H	<u> </u>	
2.053E=01	13,384	20-3770.1	0. 1.534E+00	386.	n-238
3'204E-05	196.88	3° e 6 E - 0 5	5. 2.963E-02	. 41	0-235
3.122E-01	13,44	6.622E-02	00+3878.1 .9	*902	n-53+
Absolute	a uş	KDA	Kď BCINCVEH	rsotope B	cross cuts:
gma error	18 2			•	, 2 0 10
			-9074 GDRY	h	T 4 10355.
			-8890 CWET		Factor # 2
			SO73 GASH		1 4 101367
			*527 CFF		enbye stre
7	6/60/01	std Date	000°0 WID		Defector er
	15/16/6	esed 113		•	rength of co
	17/55/6	BKQ Date	bieb ph ye		Type Analys
		eded design	3/05/31 14:02	•	Date, Time
,	11/56/9	Adda AATO	A 11sda - E 8l	r wati	Counting sys
		153	[E1370,19 201	i	ipī aīdu rģ

12/11/1991 14:26 PER NAREL MONT, ALR.

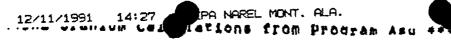
ADTR TIRETUG wer creeked 12/04/91 of 12:56 by CRIKHG,

228 3454

This listing was created 12/03/91 at 08:22 by CRIKNG.

				DOISE DY CRI	KNG.	
.Sample I	q:	R95	91.07514	DES2	••••	
Counting	# 12 m ft m m			(C) C		
Date. Te.	e conted	, AS	8 - Shelf A	_		
Tuna ta	a conuted	11/	29/91 12:33	Prep	Date 11/	26/91
Type Anal	ARIR	ם U	red by As	Bkg		22/91
Length of	count	100	A A H	Eff		19/90
Betector	@fficience		0.0 Min	8+4		19/90
Sample si	ZA		08	254	Dare 10/	09/91
Factor #	•	n.5(DOO GASH			
Festor #	•	0.96	669 GWRT			
. eccol &	2	0.98	71 GDRY			
Gross ent	#: Tsotope					
	-, isotope	AKÇ	PCI/GASH		9	Rives
U-234			. Ae. Avou	MDA	in	Sigma error
U-235	396.	9.	4	•	•11	Absolute
0-235	34.		1.683E+00	7.246E	mΛn	
U=238	388	0.	1.479E-01	1 4 4 4 5 5		48 2.346E+01
	•••	3.	1.675E+00	1.179E	02 35.5	38 6 2845 6
	7	MINLY	7-	4.682E	02 13.8	
Pross onts		טיהב א	3.5	1		4% 2.317E-01
-ross cuts	: Isotope	Bkg			_	
**	•	-14	PCI/GWET	MDA	. 2	Sigma error
U~234	396.	_		ADA	in	Absolute
11-235	34.	9.	1.6285+00	• • •		
U-238	34.	٥.	1.430E-01	7.246E-	02 13,94	3 3 5 5 5 5
~~~	388	3.	1.619E+00	1.179E-	02	
	-			4.6828-	!	
•	11	MALLY	<i>3.</i> 4	00000	02 13.84	\$ 2.241E-01
ross ents:	Isotope	•	-			
		BKQ	PCI/GDRY		2	Sigma error
U-234	244			NDA	in &	s et lol
U=235	396.	9.	1.662E+00		_	Absolute
	34.	o.	************	7.246E-0	2 43 44	_
U-238	388.		1.460E-01	1.179E-0		2.315E-01
	-	3,	1.653E+00	4 6030 -		5.1975
	767			4.682E-0	2 13,84	2.288E-01
*******		N :	3.5		• • • •	
*****	<u></u>	****	*****			
тетер Менана	Récalcui		referrateria nd Written a	******	****	- <b>4</b>
****	****	<b>4</b>	NG Written 4	M DAG - 1	*********	平平市本文文文文文文

and Written To Database



### This listing was created 12/04/91 at 07:49 by CRIKNG.

Sample Id:	R95 91.07515	DES3			
Counting system Date, Time counted Type Analysis Length of count Detector efficiency Sample size Factor # 1 Factor # 2	AS 4 ~ Shelf A 12/02/91 14:05 U prep by AS 1000.0 Min 0.236 0.5012 GASH 0.6123 GWET 0.9800 GDRY		Prep Bkg Eff	Date Date Date Date	11/26/91 11/22/91 12/19/90 10/09/91

						2 Sigma error	
Gross ents:	Isotope	BKQ	PCI/GASH		MDA	in *	Absolute
U+234	229.	7.	1.2106+00		8.184E-02	16.83%	2.036E-01
U-235	11.	4.	3.816E-02	=CMDA	6.547E-02	111.07%	4,238E-02
U-238	202.	2.	1.090E+00	_	5.062E-02	17.19%	1.874E-01
	بسند `	OTHLY			•		
	Į	OI NE M	、人づ			2 81	ama error
Gross ents:	Isotope	BKq	PCI/GWET		MDA	in *	Absolute
U-234	229.	7.	7.4102-01		8.184E-02	16.83%	1.247E-01
U-235	11.	4.	2.336E-02	= <mda< td=""><td></td><td>111.074</td><td>2,595E-02</td></mda<>		111.074	2,595E-02
U-238	202.	2.	6.675E-01	********	5.062E-02	17.19%	1.148E-01
		OTAL U	. 1.4		• • • •		
•		DIMI	, p.T			2 51	gma error
Gross cnts:	Isotope	RKG	PC1/GDRY		HDA	in *	Absolute
U=234	229.	7.	1.1866+00		8.184E-02	16,834	1.995E-01
U-235	11.	4.	3.739E-02	ACKDA		111,07%	4.153E-02
U-238	202.	2.	1.068E+00		5,062E-02	17.19%	1.837E-01
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*********	*******	*****	*********	*****	*******	*******	*******
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PA NAREL MONT. ALA. LYZOLYSI AL ORIZI DY CHIKA

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**BCI\CDB**X # 18.0 8.0000E-01 84-22e PC1/GWET \$ LS. > B'8000E-01 87-33P 16/61/6 **SCINCYRH** 9.2000E-01 8Y-359 DYLE STING S 2IC ERROR ACTIVITY MUCLIDE ********* TYPE Of analysis BLUEWATER MINING U SITES さけららは私のフ BASYD other ID's

16/61/6 16/61/6

TTIWEBS # N

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16/61/6

DATE

STINU S RIC EPROR VCLIATLE MOCFIDE ******** BYSSe IAbe of suspasse BLUEWATER U MINING BITES 23reamo) BATBY Dther ID's TTIMERGENN rocerton `) 0010 16/61/6 Collection date, time 7109 semple type 11540'16 S6N di siqued

rocetton

)

Collection date, time

PCI/GDRY \$ 09°P 6.4000E=01 EY-53P PCI/GWET \$ 09° 4.2000E-01 KY=SSe \$ 09 \$ **BCI\CY8H** TO-30005 6 FY-SSE

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16/61/6
           PCIVEDRY
                     3 96°E
                                  3.6100E+0U
                                                 64-35P
16/61/6
          PCI/GKET
                     2.26
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### POST REMOVAL URANIUM/RADIUM SOIL SAMPLING BROWN-VANDEVER SEC. 24, T13N, R11W

**BVD (Background Areas)** 

Total Uranium .55/.64 pCi/g Radium 226.73/.90

**BVC** 

Total Uranium 2.9 pCi/g Radium 226 2.9 pCi/g

BVA

Total Uranium 7.0 pCi/g Radium 226 3.7 pCi/g

**BVB** 

Total Uranium 3.6 pCi/g Radium 226 3.2 pCi/g

1800 feet

2700 feet

Sec. 19 (Santa Fe Pacific)

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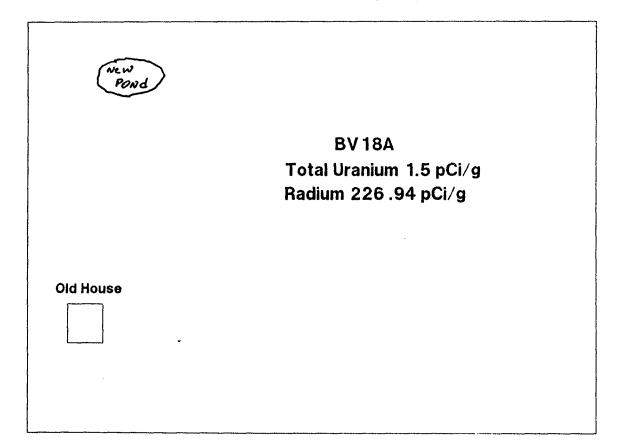
NORTH

Haystack Mountain

# POST REMOVAL URANIUM/RADIUM SOIL SAMPLING BROWN-VANDEVER SEC. 18, T13N, R10W

North

Haystack Mountain BV 18B (BACKGROUND) Total Uranium .97 pCi/g Radium 226 .93 pCi/g



NOT TO scale Figure B NAVAJO SUPERFUND PROGRAM

Nanabah Vandever SI Report

Reference

P. ANTONIO



### UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

#### **REGION IX**

### 75 Hawthorne Street San Francisco, Ca. 94105

September 22, 1991

#### **MEMORANDUM**

SUBJECT:

OSC Report for the Bluewater Uranium Mine Site,

Navajo Nation, Prewitt, New Mexico

FROM:

Robert Bornstein

On-Scene-Coordinator H-8-3

TO:

Joanne Manygoats

Navajo Superfund Program

P.O Box 2946

Window Rock, Arizona 86515

Enclosed for your review is a copy of the On-Scene-Coordinator Report for the ERS response at the Bluewater Uranium Mine Site, Prewitt, New Mexico. As you are aware, ERS conducted a mine reclamation action at the Site to reduce elevated gamma radiation levels and soil radionuclide concentrations.

I want to thank you and your staff for all of the assistance and outstanding support throughout this project. I enjoyed working with you and my stay in New Mexico. It is one of the most beautiful places in America. Please stay in touch and call me if I could be of any further assistance.

If you have any questions about the report please contact me at 415-744-2298.



### UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION IX

75 Hawthorne Street San Francisco, Ca. 94105

FEDERAL ON-SCENE-COORDINATOR'S REPORT

BLUEWATER URANIUM MINE SITES
PREWITT, NAVAJO NATION, NEW MEXICO
AUGUST 11 - SEPTEMBER 19, 1991

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

#### EXECUTIVE SUMMARY

SITE: Bluewater Uranium Mine Sites

LOCATION: Prewitt, Navajo Nation, New Mexico

PROJECT DATES: August 11- September 19, 1991

The Bluewater Uranium Mine Sites are composed of the Brown-Vandever, Brown-Nanabah and Navajo-Desiderio Mines. The Sites are located approximately five miles west of Prewitt, New Mexico and lie with in the Grants Uranium Mining District. The Brown-Vandever and Brown-Nanabah mines are located on four parcels of land which includes two Indian Allotment parcels, on Federal parcel administered by the Department of Energy and one privately owned parcel.

At the request of the Agency for Toxic Substances and Disease Registry (ATSDR) and the Navajo Superfund Program, EPA ERS was requested to assess the radiological conditions at the sites and to evaluate if a removal action was warranted. A radiological assessment was conducted in November of 1990 by EPA ERS and assisted by the Office of Air and Radiation, Las Vegas.

Elevated gamma emissions (exceeding fifty times background in certain locations) were detected during the assessment. In addition, elevated concentrations of radionuclides were detected within on site soil.

After careful review by EPA ERS, the Office of Air and Radiation (OAR), and ATSDR, it was determined that a response action was warranted at the Sites. After several coordination meetings with several agencies, including the Department of Energy, Department of Interior's Bureaus of Indian Affairs and Land Management, it was decided that EPA should proceed with a response. DOE, which owns portions of the Brown-Vandever Site will conduct its own response on its lands pursuant to Executive Order 12580.

To reduce the immediate potential radiological hazards associated with the two mine sites, ERS conducted the following response actions:

#### Phase 1

Applied earth cover to effectively reduce gamma radiation emissions and potential for radionuclide migration.

#### Phase 2

Filled, sealed and capped mine adits, inclines and ventilation shafts to reduce the migration of radon gas emissions.

### Phase 3

Revegetated and posted warning signs of reclamated areas.

Post response gamma surveys reveal that the gamma radiation levels have been effectively reduced to natural conditions. EPA and ATSDR concur that the sites have been adequately reclamated to levels which are protective of public health.

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#### I. SUMMARY OF EVENTS

### A. SITE CONDITIONS AND BACKGROUND

#### 1. Initial Situation

On October 3, 1990, the Emergency Response Section (ERS) was notified by the Agency for Toxic Substance and Disease Registry (ATSDR) of the potential health hazards associated with the uranium mine tailings, waste and debris located at the Brown-Vandever, Brown-Nanabah, and Navajo-Desiderio Mine sites (the Bluewater Uranium Mine Sites). After collecting limited data and conducting several site visits, ATSDR concluded that the Sites may pose a significant health hazard to the local population because of the presence of radioactive mine tailings, physical hazards, and potential for heavy metal contamination. On November 21, 1990, as a result of their investigations, ATSDR issued a Public Health Advisory pursuant to Section 104(i)(6)(H) of CERCLA concerning the Sites.

EPA Region IX ERS was tasked to assess the present radiological and geochemical conditions at the Sites and to determine if an emergency response action was warranted.

The Bluewater Uranium Mine Sites consist of three nearby abandoned mining areas, the Brown-Vandever, Brown-Nanabah and Navajo Desiderio Mine, which are located in the central portion of western New Mexico. The Brown-Vandever and Brown-Nanabah mine sites are located on four parcels of land, which include two Indian Allotment parcels (Section 24, Township 13N, Range 11W and

Section 18, Township 13N, Range 10W), one Federal parcel administered by the Department of Energy (Section 13, Township 13, Range 11W), and one privately owned parcel (Section 19, Township 13, Range 10W). The Desiderio Mine consists of one parcel of Indian Allotment property located on Section 26, Township 13N, Range 10W. All of these parcels lie within the Bluewater U.S. Geological Survey (USGS) Quadrangle (see Figure 1-3). The EPA has conducted response actions on all three Indian Allotments; while Cerrillos Land Company, Santa Fe Pacific Railroad and the Atchison Topeka, and Santa Fe Railway responded to Section 19 under an EPA CERCLA 106 Order. The United States Department of Energy has assumed responsibility in overseeing the response actions on Section 13 pursuant to Executive Order 12580.

The Brown-Vandever and Brown Nanabah parcels are located at the foot of Haystack Butte located approximately five miles west of Prewitt, New Mexico and 15 miles north of Grants, New Mexico. The elevation of the Site varies from 6900 to 7100 feet above sea level. The Desiderio Mine site lies approximately five miles east of the other two sites and is located on Section 26, Township 13N, Range 10W. All of the sites lie within the Ambrosia Lake Subdistrict of the Grants Uranium Mining District. The Brown-Vandever and Brown-Nanabah site encompasses approximately 155 acres, with approximately a third of this area disturbed and scared by uranium mining. The Navajo-Desiderio site covers approximately 130 acres, with nearly 30 acres disturbed by mining

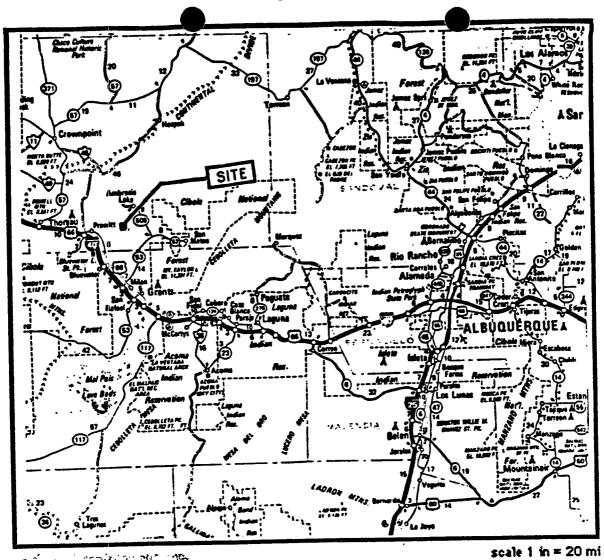


FIGURE 1 Site Location Map

Source: AAA Map New Mexico 1985

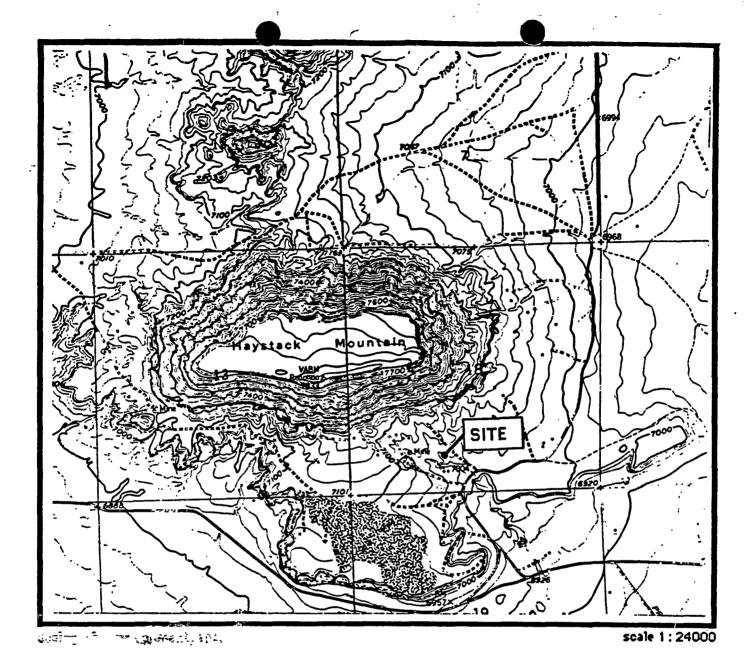
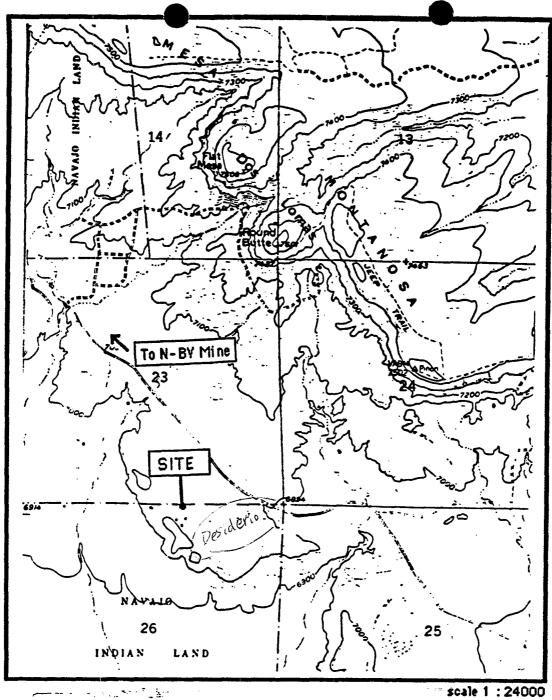


FIGURE 2 Site Location Map Navajo Brown Vandever Mine

Source: USGS map Bluewater, NM Quadrangle 1980



** scale 1 : 24000

# FIGURE 3 Site Location Map Navajo Desiderio Mine

Source: USGS Map

Dos Lomas, NM Quadrangle

1980

.5

activities (Photo A-D).

Geology locally consists of exposures of Jurassic Todilto limestone and Entrada sandstone. Vegetation consists of sparse grassland and pinyon-juniper woodlands.

Several families live and work near the Site. Approximately forty people, including children, live within one quarter mile of the Brown-Vandever and Brown-Nanabah sites. Approximately thirty people live on the Navajo-Desiderio site. The residents primarily utilize the affected mine areas to graze livestock. In addition, it was reported by ATSDR and the Navajo Nation Superfund that children often play in the mined areas.

### 2. Location of Hazardous Substances

The uranium ore is primarily calcium carnoite,

CaO-2UO3-V2O5-nH2O, which disseminates through the Todilto

limestone. Operations at the sites consisted of both open pits

and underground mining techniques. Open pit mining was conducted

predominantly with large front end loaders and haul trucks. The

overburden, consisting of topsoil, alluvium and sandstone was

blasted, removed and placed in large waste piles. It is estimated

by the Navajo Nation that 25,000 tons of uranium ore was removed

from these sites. Mined ore which failed to contain significant

quantities of uranium were discarded at the mine sites; and no

formal reclamation program was undertaken after mining operations

ceased. Because of the dry climate and lack of chemical

weathering, these mining tailings and waste remained exposed and



Photo A. Mine waste and protore (low grade ore) on Section 24, Brown-Vandever Allotment. (photo by Robert Bornstein)

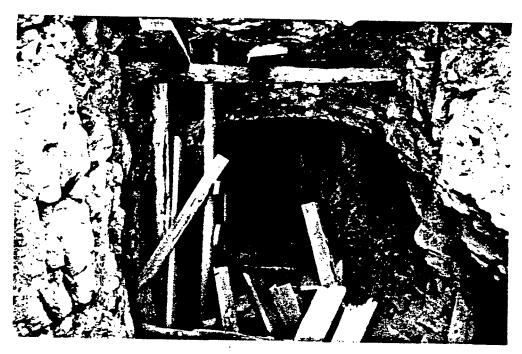


Photo B. Open mine adit located on the Navajo-Desiderio Mine Site. (photo by Craig Dodd, REAC)



Photo C. Protore (low grade uranium ore) and overburden piles on the Navajo-Desiderio Mine site looking North from residence. (photo by Robert Bornstein)



Photo D. Large open pits and protore on the Navajo-Desiderio Mine Site looking east from residence. Mt. Taylor in background. (photo by Brad Shipley).

the landscape scared.

### 3. Cause of the Release or Discharge

As a result of mining operations, uranium bearing rock and soil littered the Sites. On November 15-16, 1990, the ERS staff, assisted by members of the EPA Office of Air and Radiation, conducted a field gamma survey and collected water and soil samples on and about the Brown-Vandever, Brown-Nanabah, and Desiderio Mine sites.

In order to assess the conditions present at the sites, the ERS staff using standard radiation detection equipment (Ludlum model 19), first obtained background radiation measurements at a distance of 2.5 miles, 1.0 mile and approximately .5 miles from the sites. ERS staff took radiation readings at several sampling locations within the immediate vicinity of the sites.

Measurements were taken at both ground level and at waist level. Waist level measurements are indicative of human exposure levels, whereas the contact measurements taken at ground level suggest the emission rate of the radioactive materials from the soil.

Ground level background readings obtained by the ERS staff ranged from 11 microroentgens per hour (uR/hr) to 20 uR/hr, while waist level background readings ranged from 11 uR/hr to 15 uR/hr. Within the immediate vicinity of the sites, the net waist level (background subtracted) radiation levels ranged from 20 uR/hr to over 750 uR/hr. On ground contact, the maximum on-Site radiation level was recorded over 1000 uR/hr.

Elevated concentrations of radium (Ra-226/228) and uranium isotopes (U-223/224/235/238) were also detected in on-site soils. The maximum levels detected for radioisotopes in surface soils at the sites (within the top 15 centimeters of soil) were radium, which was measured in excess of 260 picocuries per gram of soil (pCi/g) and for uranium species, which were measured at more than 300 pCi/g. Soil samples which were analyzed for heavy metal contamination did not reveal any significant amount of contamination.

A more through gamma survey was conducted on August 11-19, 1991 by EPA on Section 24 (Brown-Nanabah) and Section 18 (Brown-Vandever) and Desiderio Site prior to reclamation activities (See Appendix A). The surveys were conducted using a 50 foot by 50 foot grid. Figures 4-6 show the respective results from the surveys.

Radiation is a known carcinogen, mutagen and teratogen. Exposure to elevated gamma radiation is known to cause cancer, cataracts, and shorten the life span of affected individuals. As indicated above, elevated radionuclide levels were detected at the sites in both the soil and waste materials. These radionuclides have been found to emit radiation at levels which may present a danger to populations in the vicinity of the Site. Uranium and several of its decay daughters are alpha emitters. The inhalation of radionuclides that are alpha emitters exposes an affected individual's internal organs to damaging alpha radiation. Once

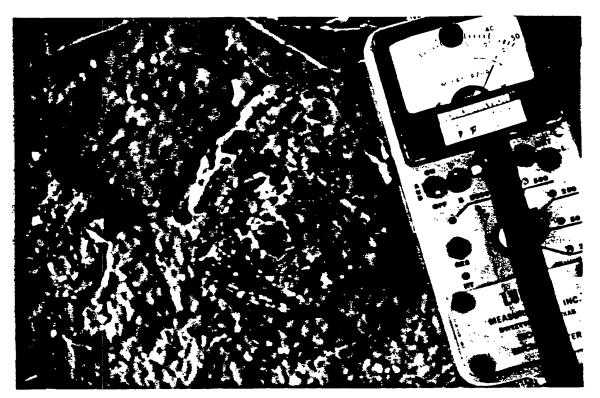


Photo E. Todilto limestone containing uranium ore. Meter is reading 230 uR/hr. (photo by Jerry Gels, REAC)

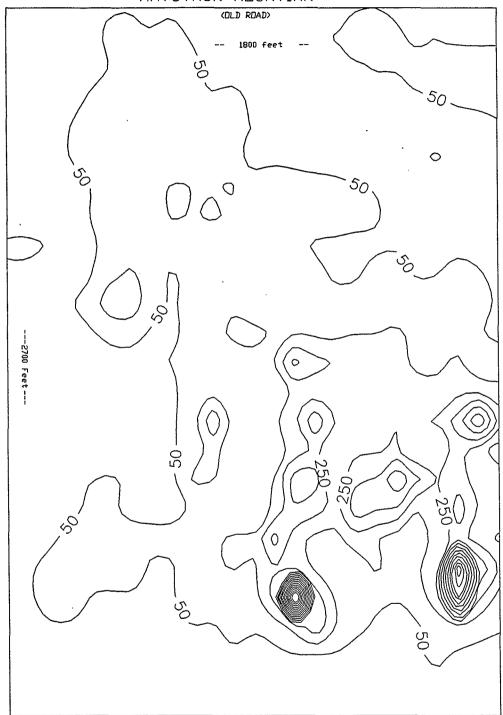


Photo F. Gamma survey being conducted by Chris Dodd, REAC on Section 18 (Brown-Vandever). (photo by Robert Bornstein)

Figure 4.

## PRE-RECLAMATION NANABAH ALLOTMENT (SEC. 24, T13N, R11W)





### LEGEND

VALUES IN uR/Hr

Survey Conducted on 50' X 50' Grid

Waist Level Measurements

100 uR/Hr Contour Interval

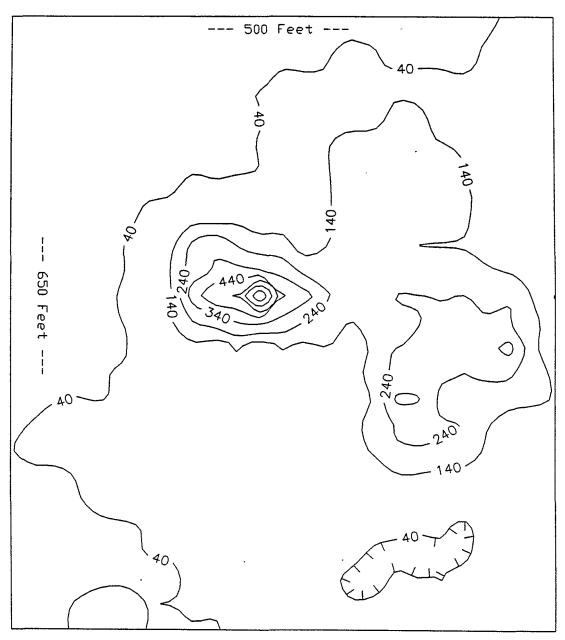
12

NORTH

SECTION 19 (Santa Fe Pacific Minerals)

## Figure 5. PRE-RECLAMATION

### BROWN-VANDEVER ALLOTMENT (SEC. 18, T13N, R10W)



### LEGEND

NDRTH

VALUES IN uR/Hr

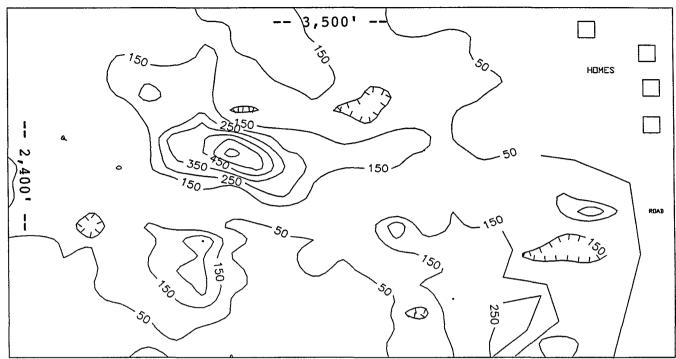
Survey Conducted on 50' X 50' Grid

Waist Level Measurements 100 uR/Hr Contour Interval

ERS Graphics 9/91

Figure 6.

PRE-RECLAMATION
NAVAJO-DESIDERIO MINE SITE



#### LEGEND

VALUES IN uR/Hr

Survey Conducted on 100' X 100' Grid

Waist Level Measurements 100 uR/Hr Contour Interval

ERS Graphics 9/91

ingested, the alpha emitters become trapped within the body, and can thereby cause severe organ damage as well as certain genetic defects.

#### 4. Efforts to Obtain Response by Responsible Parties

#### a. Federal and Indian Allotments

The Bluewater Uranium sites consist of parcels administered, owned and/or operated by several entities. An interagency task force consisting of representatives of the Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), Department of the Interior (DOI), Department of Energy (DOE), EPA, Navajo Nation Superfund Program (NSF), Indian Health Services (IHS), and ATSDR was organized to discuss response options for the sites. The Region IX Emergency Response Section (ERS) began an ongoing dialog with local and regional BIA and DOI representatives in late 1990, in order to ensure close coordination between all Federal Agencies regarding a response action at the Bluewater Sites. To acquire specific information regarding the leases at the Sites, EPA issued BIA a CERCLA 104 Request for Information. Several of the leases on the Indian Allotments contained reclamation clauses that appeared not to be enforced.

On April 8, 1991, members of the BIA, BLM, DOI, IHS and Navajo Nation met to discuss response activities. EPA ERS could not attend the meeting in Albuquerque because of travel restrictions. At the meeting, it was determined that EPA most

likely could provide the most expedient response.

A second Interagency meeting was held on June 3, 1991 to visit the Sites and discuss the time critical actions and potential cooperative agreements. At this meeting, the DOE stated it would assume full responsibility in conducting response actions on the DOE parcel (Section 18).

At this meeting DOI OEA stated it would try to enter into an Interagency Agreement (IAG) with EPA to conduct the response activities on the Indian Allotments. Several drafts of the IAG were created and revised by both EPA and DOI OEA.

For several months, an effort to develop an IAG for the response action was undertaken by ERS and DOI representatives. Pursuant to the terms of the negotiated IAG, ERS was to conduct the response activities at the site, and DOI was to reimburse EPA for specified costs of the response, pursuant to its authority under the Snyder Act.

In drafting the IAG, EPA Region IX was well aware of DOI's sensitivity concerning the possible precedent which the Agreement might establish for the remediation of other BIA-adminstered mining sites. In light of this concern, EPA Region IX crafted site-specific IAG language, to minimize the implication of BIA liability for site remediation under CERCLA. While the proposed IAG still referred to CERCLA (as the statutory basis for EPA's response activity at the sites), it also specifically referenced the Snyder Act (as the authority supporting BIA reimbursement of

EPA's response costs). Furthermore, the IAG itself stated that BIA's agreement to pay EPA for certain costs of the response action would in no way constitute an admission of liability under the Act. Finally, a special condition to the IAG clearly indicated that the Agreement was not to be viewed as a precedent for the payment of EPA's response costs at other sites in Indian country.

Since the time of the first Interagency meeting concerning the Bluewater sites, it has been EPA's understanding that DOI representatives in Washington D.C. had been generally apprised of the development of the IAG, and had received copies of the relevant correspondence concerning this cooperative effort. Based on this understanding, EPA sent the proposed agreement to DOI Assistant Secretary John Schrote for signature on July 15, 1991.

Thereafter, on August 1, 1991, DOI representatives informed EPA Region IX that, contrary to previous indications from local and regional DOI officials, the DOI would not agree to participate as a signatory to the IAG.

DOI officials believed that the Agreement might be viewed by other parties as a precedent for future response actions. DOI proposed to EPA that it would perform the necessary response actions on the Indian Allotments.

In response to DOI's concern, EPA first offered to revise the IAG, to incorporate any new language that DOI might suggest.

However, DOI responded that it was the very concept of the IAG,

rather than its specific language, that was objectionable to the Department. EPA then indicated that it would consider DOI's proposal to perform the response action. However, EPA stressed the need for prompt action at the sites. A deadline of August 5, 1991 was agreed upon for DOI to submit to EPA a work plan outlining its response action and schedule. The August 5 deadline passed without any additional communication between DOI and EPA. On August 6, EPA still did not receive a firm commitment from DOI to promptly initiate work at the sites. DOI informed EPA that it was having problems obtaining the required funding to perform the site response and that a special request to Congress was required. This request was estimated to take at least two to three weeks.

Given the serious health hazards which the sites posed and the need for prompt action to abate those hazards, EPA had no choice but to proceeded on schedule to undertake the required response activities.

EPA is coordinating with the EPA Headquarter Federal Affairs
Office and the Department of Justice to further investigate
options on seeking cost reimbursement from DOI.

#### b. Private Land

EPA conducted a Potential Responsible Party search to investigate the historical mining records. The PRP search revealed that the mineral rights for Section 19, Township 13N, Range 10W was held and controlled by the Santa Fe Pacific Railroad Company (SFPR). SFPR owned the mineral rights to the site for the

period from 1951 to the early 1980's. During this period of time, uranium mining operation were conducted at the site. In mid-1980, mineral rights were transferred to Cerrillos Land Company, a SFPR company.

From November 21, 1950, to September 30, 1952, SFPR conducted drilling, sampling, test pitting and other mining operations at the Site. According to the mineral leasing history and corporate chronology supplied to EPA by Mr. Tim Leftwich, Director of Environmental Quality for both the Cerrillos Land Company (CLC) and the Santa Fe Pacific Minerals Corporation (SFPM), the Haystack Mountain Development Company (HMDC) was incorporated on October 15, 1951, as a subsidiary of the Atchison, Topeka and Santa Fe Railway. From September 30, 1952 to November 30, 1961, SFPR formally leased the mineral rights to Section 19 to HMDC. From September 30, 1952 to November 30, 1961, HMCD conducted mining operations on Section 19.

From the mining history record, EPA served a CERCLA 106
Unilateral Order to Cerrillos Land Company, Santa Fe Pacific
Railroad Company and the Atchison, Topeka and Santa Fe Railway
Company (ATSF) on July 29, 1991.

On August 13, 1991, a conference was held in Albuquerque with the respondents of the Order. It was agreed upon that Cerrillos Land Company would assume the "lead" entity during the response action and that the respondents would comply with the Order. On August 26, 1991, Taylor Excavation mobilized on Section 19 to begin reclamation activities for Cerrillos Land Company.

#### B. ORGANIZATION OF THE RESPONSE

On June 10, 1991, Jeff Zelikson, Director, Hazardous Waste Management Division, Region IX approved the Action Memorandum. Pursuant to OSWER Directive 9360.0-19, the Bluewater action is considered nationally significant, and therefore, required EPA Headquarter's concurrence. After much anticipation, on July 26, 1991, Henry Longest, Director of the Office of Emergency and Remedial Response concurred on the Action Memorandum. With Headquarters approval, ERS prepared to conduct the response.

The response action was conducted in three phases. Phase 1 contained activities to further characterize and define areas with elevated gamma radiation readings; Phase 2 dealt with the excavation and covering of uranium ore, mine waste, and closing of shafts and adits; and Phase 3 involved revegetation activities and the posting of warning signs.

- * Phase 1 Definition and Extent of Problem
  - Conduct extensive gamma survey using a 50' X 50' grid.
  - Evaluate soil and overburden piles for use as cover.
- * Phase 2 Excavation and Earth Moving Activities
  - Fill and cover in all open pits with radioactive materials.
  - Reduce elevated gamma radiation readings to below 50 uR/Hr.
  - Fill and Close all shafts, adits and inclines.
  - Conduct Post Removal gamma surveys to ensure proper clean-up levels.

- * Phase 3 Revegetation and Posting
  - Disk and Drill seed mixture.
  - Post warning signs in English, Navajo and Spanish to advise people to not disturb the reclamated surface.

To conduct Phase 2 and 3 activities, EPA Region IX contracted with Laguna Construction Company. A site specific contract was negotiated between Jeri Simmons, Region IX Contracting Officer and Neal Kasper, President of Laguna Construction. Laguna Construction was selected by EPA Region IX for the following reasons:

* Experience in the field of Uranium Mining Reclamation

Laguna Construction was established with the assistance of the Bureau of Indian Affairs and the Publeo of Laguna to perform the mine reclamation action at the Jackpile Mine, the world's largest open-pit uranium mine. Laguna construction has moved over 11.8 million cubic yards of material at Jackpile and has built an outstanding track record in mine reclamation actions.

The Bluewater response action required similar actions and expertise demonstrated by Laguna Construction at Jackpile. In addition, Laguna Construction was the most qualified mine reclamation contractor in the Bluewater-Grants Mining District. The company was familiar with the regional geology and topography.

#### * Minority owned and Operated Business

It is the policy of the EPA to enter into contracts with small minority business that could adequately perform the tasks. Laguna Construction is a wholly owned and operated enterprise of the Pueblo of Laguna Indians. EPA wishes to use an Indian owned and operated company on Indian Lands.

EPA Region IX believed that a site specific contract to conduct this action would be more practical and cost efficient rather than issuing a delivery order to the present ERCS

contractor.

To assist in conducting the radiological surveys and providing site health physicist support, ERS utilized the expertise and experience of the Environmental Response Team's (ERT) radiological support staff and its contractor Weston (REAC). Additional radiological support was provided to ERS by EPA Region IX Office of Air and Radiation (OAR). Both ERT/REAC and OAR provided invaluable support and expertise throughout the response action. Additional site support was provided by the Navajo Superfund Program (NSP). Table 1 outlines the organization of the response and lists key site personnel contacts.

#### C. INJURY/POSSIBLE INJURY TO NATURAL RESOURCES

Wildlife species in the area of the Sites are restricted to birds, reptiles, and small mammals characteristic of the pinyon-juniper and grassland habitats. This includes rabbits, foxes, field rodents, rattlesnakes, hawks, blue birds, and other creatures. Livestock utilizing the sites are horses, cows, goats and sheep. Continuous exposure to the elevated gamma emissions could adversely impact local wildlife and grazing livestock.

#### 2. Trustee Damage Assessment and Restoration Activities

No formal endangerment assessment was performed at the sites by the Department of the Interior or EPA.

The affected reclamated areas were revegetated using native

Table 1. Organization of Response

AGENCY/PARTY	CONTACT	DESCRIPTION OF DUTIES	
USEPA-REG IX Emergency Response H-8-3	Rob Bornstein	Federal OSC, responsible for all site operations	
75 Hawthorne Street SF, CA 94015 415-744-2298	Bill Weis	Enforcement Investigator Cost Recovery Specialist	
USEPA-ORC 75 Hawthorne Street SF, CA 94105 415-744-1359	Linda Wandres	Attorney assigned to the site	
USEPA-OAR 75 Hawthorne Street SF., CA 94105 415-744-1049	Steve Dean	Health Physicist Radiation Support	
USEPA-ERT 26 W. MLK Dr. Cinn., OH 45268 513-569-7537	Art Ball	ERT Response Manager Radiation Support	
Weston REAC 11 Spiral Dr. Suite 6-7, Bldg. B Florence, KY 41042 606-282-7868	Jerry Gels	Health Physicist Radiation Support	
	Craig Dodd	Radiation Support	
Navajo Superfund P.O. Box 2946 Window Rock, AZ 602-871-7331	Pat Antonio Stan Edison Guarva Rajen	Assisted in PA/SI and Response Support	
Laguna Const. P.O. Box 206 Laguna, NM 87026 505-552-6000	Neal Kasper Jack Presnell	Prime Contractor conducting response	
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grass species. Additional pinyon and juniper trees will be planted by the Navajo Nation in early Spring of 1992.

#### D. CHRONOLOGICAL NARRATIVE OF RESPONSE ACTIONS

#### 1. THREAT ABATEMENT ACTION TAKEN

#### a. Phase 1

Phase 1 activities commenced on August 12, 1991. OSC
Bornstein assisted by Art Ball (ERT), Jerry Gels (REAC), Ken
Munney (REAC) and the Navajo Superfund laid out a 50 foot by 50
foot grid across the hummocky topography on Section 24 and Section
18 of the Brown-Vandever-Nanabah Allotments. The grid was laid
across an area of 1800 feet East-West by 2700 feet North-South on
Section 24 and 650 feet North-South by 150 feet East-West across
Section 18. A modified 50 foot by 50 foot survey utilizing the
site's aerial photograph was performed on the Desiderio mine site
(refer to Figures 4-6).

After the grids were established, a Ludlum model 19 instrument was utilized to conduct a thorough gamma survey. Gamma readings were collected at both waist level and ground contact at each grid node. A second survey was conducted at waist level targeting limestone contacts and rubble to pin point "hot spots."

During the week of August 11, 1991, surveyors from Laguna

Construction surveyed and developed contour maps on each affected section.

#### b. Phase 2

Phase 2 activities began on August 19, 1991 with the

mobilization of Laguna Constructions equipment and personnel.

Mobilized on site to conduct the earth moving activities were
three Cat D-9N dozers, one Cat D-6H dozer, one Cat 14G grader and
one Cat 980C front end loader. In addition, Laguna Construction
mobilized a lube and fuel truck, mechanic truck, fuel storage
tank, and lunch room. All of the equipment arrived on schedule
and in excellent working condition.

Earth moving activities began on Section 24 (Brown-Nanabah Allotment) on August 19, 1991. The D-9N dozers were utilized to push and cut the large piles of overburden fill. Piles containing "clean" fill (gamma readings of 20 uR/hr or less) were isolated and stockpiled for use as cover material. The large pits were first back filled with protore (low grade ore) and mine tailings and then covered with 1-3 feet of "clean" fill. After an area was completed, a gamma survey was conducted to ensure that gamma levels were under 50 uR/hr. Areas exceeding 50 uR/hr were flagged by ERT/REAC personnel and latter reworked. Laguna Construction completed earth moving activities on Section 24 on August 27, 1991. From August 27-31, earth moving activities were performed on Section 18.

Activities on Section 18 included back filling a large open adit, recontouring area drainage channels away from reclamated zones, and installing a drainage culvert.

On September 2, 1991, all of the tractors and support equipment were transported to the Navajo-Desiderio site. Earth

moving activities on the Desiderio site included the back filling of several large (up to 30 feet deep and 50 yards across) pits, the sealing and closure of a mine adit, the transportation, burial and covering of large protore piles, and the rechannelling and grading of drainage channels. Earth moving activities at the Desiderio site were completed on September 18, 1991. A 100 foot by 100 foot survey was conducted over the reclamated area to ensure that gamma radiation readings were below 50 uR/hr. Laguna Construction demobilized its equipment on September 19-20, 1991.

Throughout earth-moving activities, REAC conducted air monitoring using an aerosol particulate monitor to assess if level C personnel protection was necessary. At no time was level C personnel protection required during the response. Appendix B summaries the results of this study. Photos G-N show Laguna Construction equipment at work.

#### c. Phase 3

Phase 3 activities began in early September with the posting of the warning signs. The signs were placed along the perimeter of each reclamated section. Each sign was in English, Navajo and Spanish (see photo 0). James Ranch was subcontracted by Laguna Construction to perform the revegetation activities. On September 18, 1991, James Ranch personnel and equipment mobilized at the Brown-Vandever site. The reclamated zones were disked and drill seeded using a mixture of native grasses. By September 21, 1991, James Ranch completed the job reseeding 70 acres of reclamated

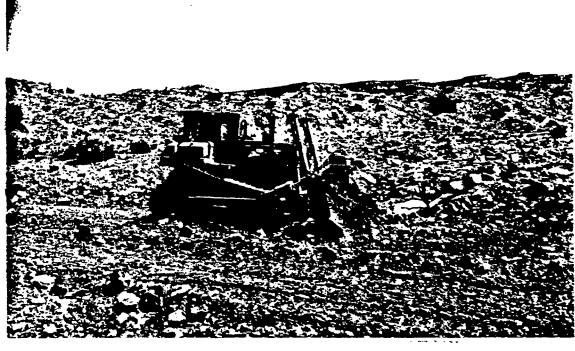


Photo G. Laguna Construction Cat D-9N pushes mine tailings and protore on Section 24 (Brown-Nanabah). (photo by Robert Bornstein)

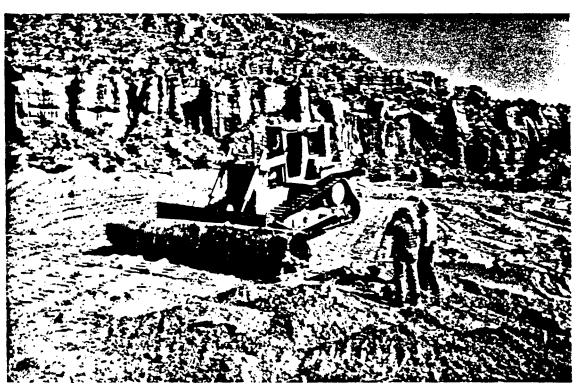


Photo H. Drainage colvert being installed by Laguna Construction on Section 18 (Brown-Vandever). Drainage routes were directed around reclamated areas. (photo by Jerry Gels, REAC)

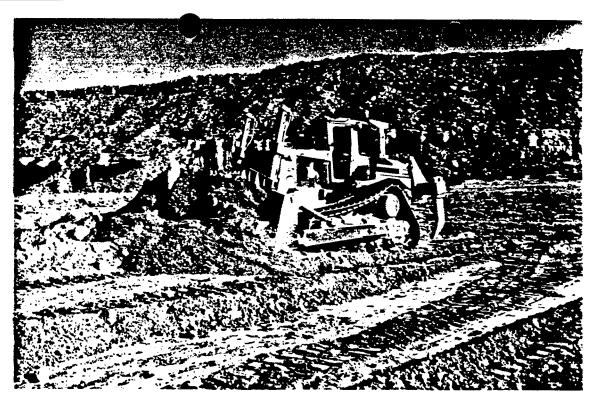


Photo I. A D-9N pushes "clean" fill over burried protore and mine tailings on Section 24 (Brown-Nanabah). Note, Haystack Mountain in background. (photo by Robert Bornstein)

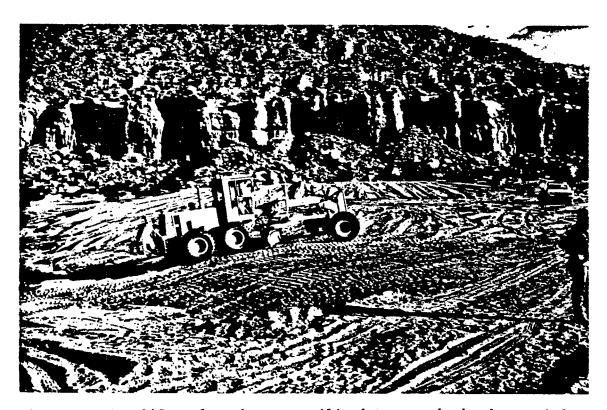


Photo J. A Cat 14G road grader was utilized to smooth the dozer wind rows and prepare the site for reseeding. Photo is taken looking north on Section 18 (Brown-Vandever). (photo by Robert Bornstein)



Photo K. A D-9N tractor pushes mine tailings and overburden into one of the many large open pits at the Desiderio Mine Site. (photo by Robert Bornstein)



Photo L. D-9N tractors, Cat 14G road grader and a 980C-front end loader complete mine reclamation activities on the Desiderio Mine Site. (photo by Robert Bornstein)



Photo M. A D-9N completes the finishing smoothing activities on Section 18 (Brown-Vandever). (photo by Robert Bornstein)



Photo N. Two massive D-9N work to fill in large pit on the Desiderio Mine Site. (photo by Robert Bornstein)



Photo O. Posted warning sign on Section 18 (Brown-Vandever).

Note that the signs are in three languages: English, Navajo, and Spanish.(photo by Jerry Gels, REAC)



Photo P. Completed Section 24 looking south-easterly from section line. (photo by Jerry Gels, REAC)

land.

#### 3. Public Information and Community Relation Activities

EPA's Office of External Affairs issued a press release informing the media of the response action. In addition, a Navajo Nation sponsored Press Conference was held on August 28, 1991 at the Baca Chapter House. Navajo President Peter Zah and OSC Robert Bornstein informed the media of the response action and answered several questions. Following the press conference, the media was invited to the site for a tour. News reports and articles regarding EPA's actions appeared on local TV stations and newspapers including the Albuquerque Journal, Navajo Times, Grants Beacon and Gallup Independent.

Throughout the response action, OSC Bornstein assisted by the Navajo Superfund informed the local residents on the progress and success of the response actions. A grant was given to the Navajo Superfund Program from ATSDR to conduct further community relation activities to inform the general public of the hazards of old uranium mines.

Copies of the Administrative Record were sent to the libraries in Grants and Gallup, New Mexico.

#### E. RESOURCES COMMITTED

The Emergency Response Section incurred a total estimated cost of \$332,565.00. Out of this amount, \$233,901 is for extramural costs associated with the work conducted by Laguna Construction. The remaining costs are for TAT, REAC, ERT and EPA.

Table 2 outlines the cost breakdown to date. EPA Region IX is consulting with EPA HQ Office of Federal Affairs and the Department of Justice in pursuing the Department of the Interior with cost recovery.

Table 2. Estimated Project Cost Summary

4			
	ite Total aguna Construction AT/REAC	\$629,770.00 \$300,877.00 \$ 56,000.00	
Extramural Co	osts: aguna Construction	\$233,901.00	
EPA Contract Costs			
T	AT - Ecology and Environment	\$ 6,156.00	
REA	AC - Weston	\$ 30,000.00	
EPA/ERT Costs			
EP	A/ERT	\$ 62,508.00	
RESPONSE TOTA	AL TO DATE	\$332,565.00	

#### II. EFFECTIVENESS OF REMOVAL ACTION

The following response activities were completed by September 18, 1991:

- * Filled, graded and applied an earth cover to areas emitting elevated gamma radiation;
- * Filled, sealed and capped mine adits, inclines and shafts;
- * Posted warning signs on site to advise people to not disturb reclamated areas;
- * Revegetated affected zones with natural grasses.

The National Council on Radiation Protection and Measurements (NCRP) Report 91 (1987) recommends the adoption of a limit for continuous or frequent exposure to radiation, at 100 mrem/yr effective dose equivalent (EDE) from all radiation sources (including external as well as internal sources but excluding natural background and medical exposures). The NCRP report also recommends that a limit of 500 mrem/yr be established for infrequent or "short term" exposure. In accordance with the above referenced NCRP guidelines, EPA's Office of Air and Radiation (OAR) has concurred with Region IX's Action Memorandum for the Bluewater Sites, which recommends that a limit of 100 mrem/yr of excess gamma radiation be adopted as a standard in this case.

Natural background gamma radiation from external sources in the vicinity of the Bluewater Uranium Mine Sites varies considerably and is dependent upon local geology. It may be as low as 12 uR/hr in areas lacking natural uranium deposits and as high as 20 uR/hr in areas containing uranium rich ore. Naturally exposed uranium rich Todilto limestone outcrops at the Desiderio Mine Site recorded readings as high as 50 uR/hr at waist level. For the purpose of this response action, EPA has estimated that the population in question (on average) spends two hours a day for 300 days/yr in the areas affected by mine operations. A more conservative estimate of 7 hours a day was given to EPA by the Navajo Superfund Program in May of 1991.

Navajo Superfund Program in May of 1991.

#### A. RESPONSE RESULTS

#### BROWN-VANDEVER-NANABAH SECTION 24

A 50 foot by 50 foot grid survey was conducted at the Brown-Vandever-Nanabah sites. The results of the post removal survey on Section 24, Township 13N, Range 10W of the Bluewater Quadrangle (Brown-Nanabah site) reveal that gamma radiation levels (once exceeding 500 uR/hr in places) have been drastically reduced (Figure 7). The average gamma reading within the reclaimed area is presently 28 uR/hr. The highest reading recorded within the survey was 56 uR/hr. In addition to reducing gamma radiation emissions, the covering of the protore and mine wastes most likely has reduced the surface radium and other radionuclide concentrations in the top 15 cm of soil (post analytical results are pending), as well as radon flux.

Using the average gamma reading, the population would receive a yearly excess gamma radiation dose of 7.8 mrem/yr. This compares to the average annual background radiation dose received in the United States of 300 mrem/yr as reported by the NCRP.

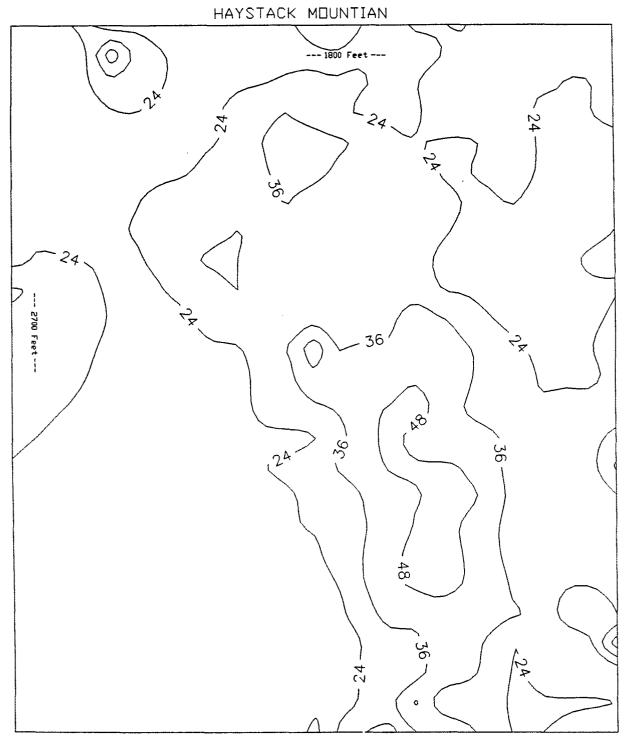
(28 uR/hr - 15 uR/hr) * 2 hours * 300 days/yr = 7800 uR/yr 7800 uR/Mr. = 7.8 mR/yr = 7.8 mrem/yr

Using the conservative estimate of 7 hours a day and the average gamma reading for section 24, the excess gamma radiation for 300 days would be 27.3 mrem/year. This exposure is also well below the NCRP standards.

Therefore, in reclaimed areas, using EPA's estimations,

## POST RECLAMATION

NANABAH ALLOTMENT (SEC. 24, T13N, R11W)



LEGEND

VALUES IN uR/Hr

Survey Conducted on 50' X 50' Grid

Waist Level Measurements

NORTH

SECTION 19 (Santa Fe Pacific Minerals)

the population frequenting the site will not receive any significant excess gamma exposure. Their excess gamma exposures would not exceed the NCRP recommendation.

For frequent exposures (long term) the NCRP recommends populations to not exceed 100 mrem/yr EDE from all sources (excluding natural background and medical sources). With background being approximately 15 uR/hr in the affected area, populations could reside on areas of reclaimed land reading 27 uR/hr or less to adequately stay within this guideline (assuming they are not exposed to other excess radiation sources besides uranium chain gamma). Approximately 60% of the reclaimed land is potentially suitable for full time occupancy.

These are very conservative calculations because no credit is taken for the shielding effect of the home on any increases in terrestrial radiation. Additional studies should be conducted within the reclaimed area prior to allowing any homes to be built. However, it is highly unlikely that prior to mining operations, the gamma radiation levels presently being emitted were significantly lower. It is probable that some portions of the strip-mined area were naturally higher than the average background elsewhere as a result of the proximity to the surface of uranium-rich ore.

Therefore, the removal action appears to have effectively reduced the potential radiological hazards associated with the abandoned mine operations and has returned the land to a

productive environment.

#### BROWN-VANDEVER SECTION 18

The post removal survey conducted on Section 18, Township
13N, Range 10W of the USGS Bluewater Quadrangle (the Brown
Vandever site) revealed that the average gamma reading was 13
uR/hr. The highest reading was 29 uR/hr. This reading is
essentially background and therefore, no additional action should
be taken on this section (Figure 8).

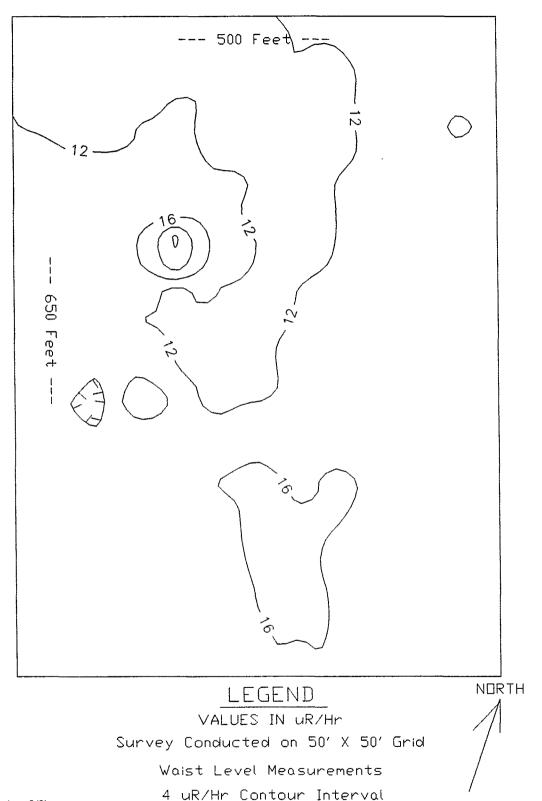
#### DESIDERIO MINE SITE

A post removal survey using a 100 foot by 100 foot grid was conducted on the top 15 acre portion (Starting at the residences and heading due east) at the Desiderio site (Section 26, Township 13N, Range 10W). This survey revealed that the average gamma reading within the reclamated area was 15 uR/hr. A random survey was conduct on the other reclamated areas near the road, the once far southern pits, and the old shaft areas. Values ranged from a high of 50 uR/hr to a low of 15 uR/hr. The average reading within these isolated locations was approximately 28 uR/hr.

Like the Vandever sections, the post removal results at the Desiderio site reveal that the gamma emissions (once exceeding 700 uR/hr in places) have been drastically reduced. Levels present at the site are well within reclamation guideline levels and pose no significant health risks for long term exposures. It is likely that the reclamated gamma emissions are no greater than those detected prior to mining operations at all three reclamated

## Figure 8. ST RECLAMATION

BROWN-VANDEVER ALLOTMENT (SEC. 18, T13N, R10W)



ERS Graphics 9/91

sections (Readings of 50 uR/hr were detected on unmined naturally occurring Todilto limestone outcrops) (Figure 9).

On September 24, 1991, ATSDR concurred with EPA that the response action was satisfactory in eliminating the potential radiological hazards and protective of public health (See appendix C contains post response data, Appendix D, ATSDR letter).

#### B. ACTIONS TAKEN BY PRPS

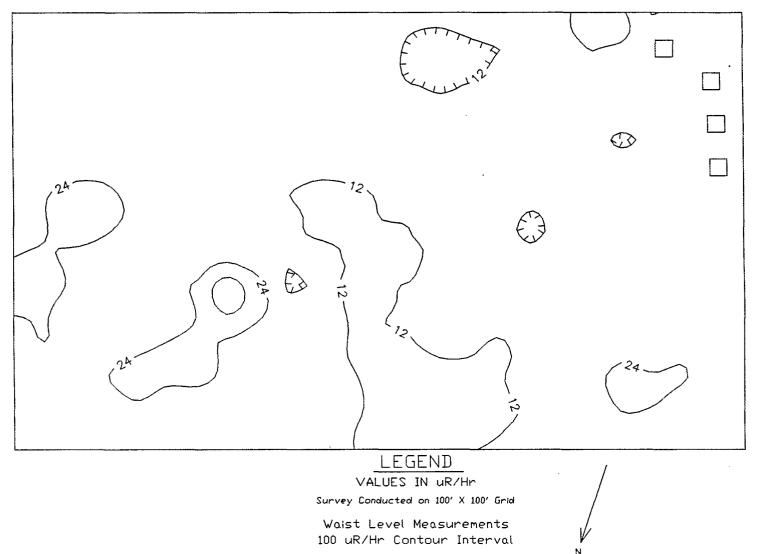
Cerrillos Land Company conducted a gamma survey on Section 19 and at the advise of EPA, Cerrillos identified "hot" spots within the grid. Cerrillos Land Company, acting as the "lead" respondent, submitted a draft site stabilization plan to EPA on August 25, 1991. In addition, Cerrillos stated that it would comply with the Order. A revised plan was accepted by EPA on August 30, 1991 and Cerrillos mobilized its contractor, Taylor Excavation, on September 4, 1991.

From September 4, 1991 to October 23, 1991, Taylor Excavation conducted earth moving activities on Section 19 to reduce the gamma radiation emissions to below 50 uR/hr.

#### C. ACTIONS BY STATE AND LOCAL AGENCIES

The Navajo Superfund Program identified the sites during 1990 as part of their Site Evaluation program. The Navajo Superfund Program played a vital and active role in pursuing a response action at the Sites. During the response action, the Navajo Superfund Program provided invaluable assistance and support throughout the response action. Members of the Navajo Superfund

# Figure 9. POST RECLAMATION NAVAJO-DESIDERIO MINE SITE



staff assisted EPA in conducting radiological surveys and public relations activities.

#### D. ACTIONS TAKEN BY FEDERAL AGENCIES

During the response activities, DOI and BIA representative were updated by EPA via pollution reports and correspondence. Copies of the post removal exposure summary report were sent to DOI, BLM, and DOI. The Grants BLM/NPS ranger station was utilized by EPA to distribute email pollution reports. Overall, BIA, BLM and DOI did not significantly contribute to the success of this response action.

DOE has informed EPA that it will pursue undertaking response activities on Section 13. DOE is presently trying to work with the mine lessee, George Warnock, in performing the required actions.

#### E. ACTIONS TAKEN BY CONTRACTORS

Three EPA contractors contributed to the success of the response action:

Ecology and Environment - TAT

- Conducted preliminary assessment and gamma survey support.

#### Weston - REAC

- Provided assistance in conducting pre and post gamma surveys.
- Provided site health physicist and radiological expertise.
- Conducted field photo documentation and assisted in data interpretations.
- Conducted air monitoring and assisted enforcing site safety plan.

Laguna Construction

- Conducted earth moving activities, sign posting and revegetation activities.

Weston REAC provided assistance throughout the removal action. Jerry Gils, REAC Health Physicist and project manager, provided outstanding field support in assisting in planning the response, conducting the extensive surveys and managing and interpreting site data.

Laguna Construction performed a superb job in reclamation.

Gamma radiation readings and soil radionuclide concentrations were significantly reduced. Every aspect of the job went successfully. Mobilization was on time, maintenance and refueling of equipment went smoothly and the sign construction and placement was performed without any problems. Laguna Construction machine operators transformed the hummocky, scared topography back to "natural" conditions. Throughout the job, each tractor was meticulously cared for and maintained. At the conclusion of the job, no radioactive contamination was found on Laguna Construction equipment.

#### III. DIFFICULTIES ENCOUNTERED

#### A. ITEMS THAT AFFECTED THE RESPONSE

The Bluewater Uranium Mine response action was the first abandoned uranium mine emergency response action performed by Region IX. The action itself was a complete success in alleviating all of the potential radiological hazards noted by the

ATSDR Health Advisory.

The most difficult problem encountered on this project was determining if a response was warranted. Presently, EPA does not have any set quidance or action levels to respond to abandoned uranium mine sites. The data from the November 1990 assessment was distributed to ATSDR, OAR and IHS for review and comments. accurately assess the data without actually spending time at the sites proved to be a difficult task. ATSDR concluded within its Health Advisory that the sites posed a significant health problem to the local population. However, the Advisory lacked data to substantiate its concerns (limited radiological data, no thorough exposure assessment, no analytical analysis). ATSDR and the Navajo Nation were convinced after reviewing the preliminary assessment data that a response action was warranted. after waiting several months for a response, OAR-HQ requested additional data from the sites before making a final determination. EPA Region IX decided that it would be prudent to conduct a response at the site since the assessment data did indicate elevated radiological readings and since a health advisory was issued concerning the site.

#### B. ISSUES OF INTERGOVERNMENTAL COORDINATION

Several interagency meetings were held to discuss the response actions at the sites. The Region IX Emergency Response Section (ERS) began an ongoing dialog with local and regional BIA, BLM, IHS, Navajo Nation, DOE and DOI representatives in order to

ensure close coordination between all Federal Agencies regarding a response action at the Bluewater Sites. For several months, an effort to develop an IAG for the response action was undertaken by EPA and regional DOI representatives. Unfortunately, it appears that DOI and it's Bureaus failed to coordinate their actions. As a result of this miscommunication, EPA was unable to successfully enter into an agreement with DOI.

#### IV. RECOMMENDATIONS

To assist in responding and evaluating future uranium mine sites, the following recommendations should be implemented:

a) Thorough and complete gamma and radiological surveys should be completed on potential sites using a 50' by 50 ' grid to accurately assess radiological conditions.

ATSDR and earlier assessments noted extremely high gamma radiation readings. However, these extremely high gamma radiation readings were often anomalies rather than the norm.

b) After completing thorough gamma surveys, exposure assessments should be conducted. Accurate data on land use and population is required to adequate assess health risks.

In order to accurate assess the risk to human health from these mine sites, a complete and accurate risk assessment should be undertaken. The following critical questions must be accurately addressed:

How often and how long do people frequent the areas? What uses are made of the land in question?

c) EPA and the BLM Office of Surface Mining (OSM) need to develop a joint strategy in addressing future mine sites.

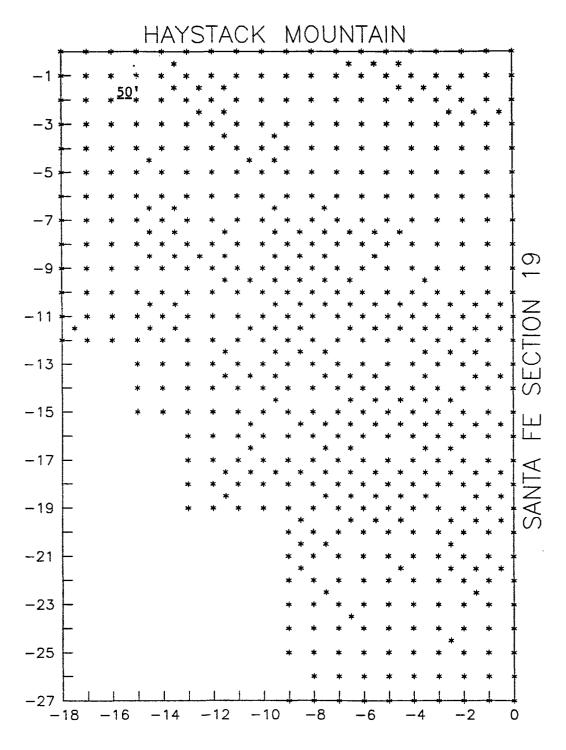
Presently, OSM is conducting mine reclamation activities under the authority of the Surface Mining Control and Reclamation Act (SMCRA). SMCRA applies to mines worked prior to August 3,

1977 and mines posing an imminent hazard to the public health and safety.

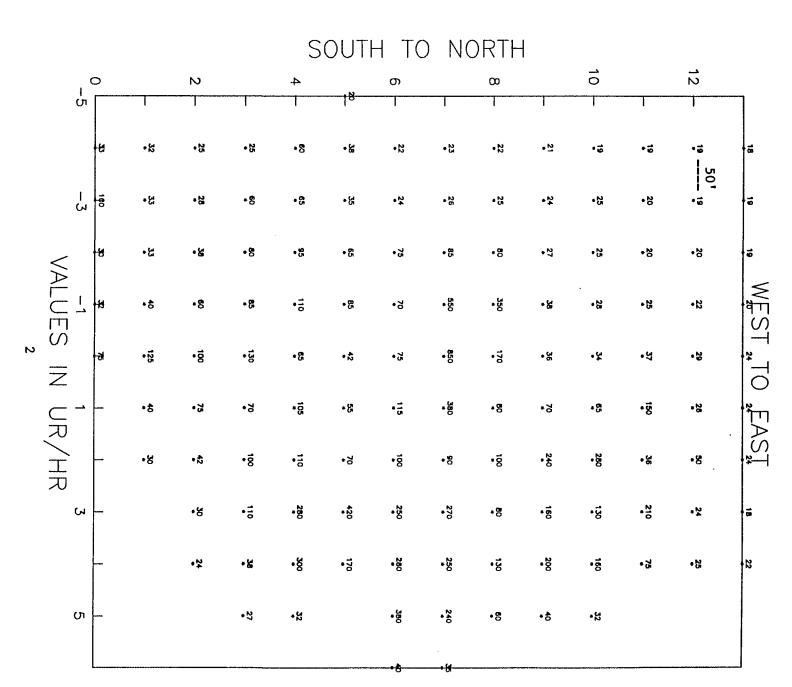
A Memorandum of Understanding should be developed between EPA and OSM agreeing that sites eligible for CERCLA actions should receive high prioritization for reclamation under SMCRA. In addition, BLM OSM should have enforcement powers to require responsible parties to undertake the required reclamation actions.

## APPENDIX A

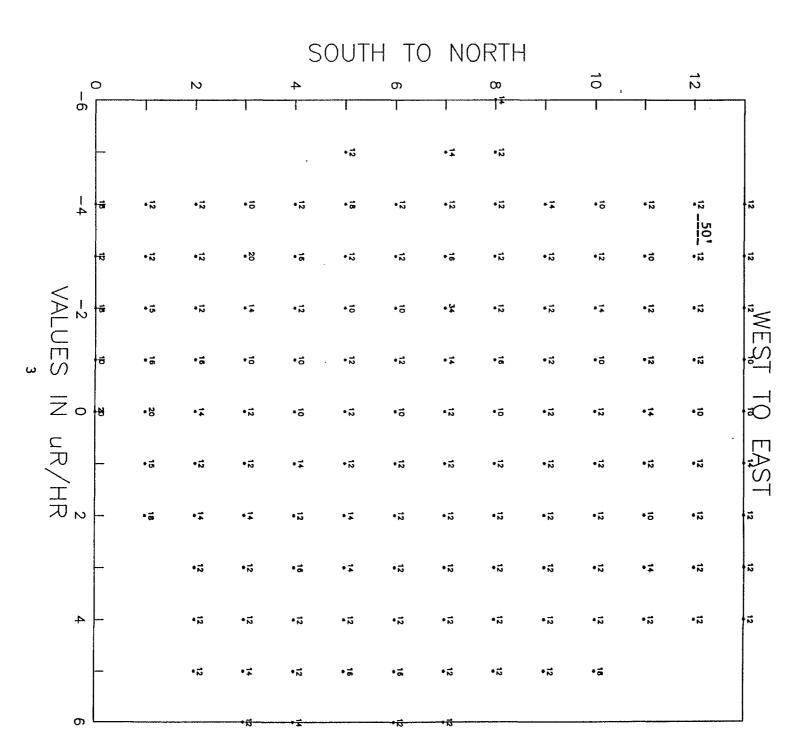
PRE-RECLAMATION GAMMA SURVEY DATA AUGUST 11-19, 1991 SURVEY STATIONS (Sec. 24, T13N, R11W)

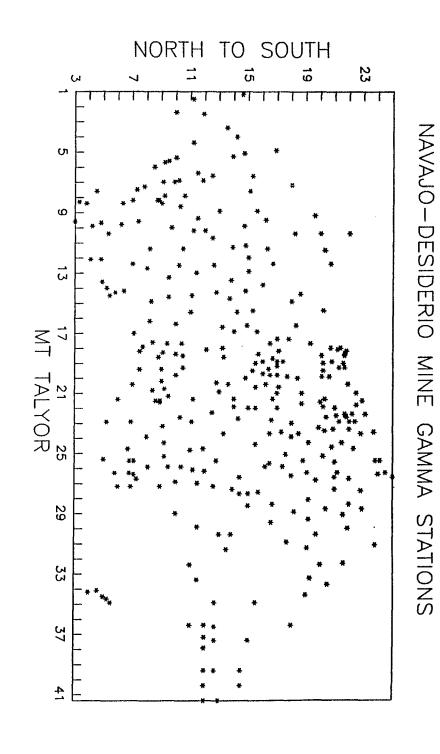


PRE RESPONSE (Sec.  $\frac{1}{2}$ T13N, R11W)



POST RESPONSE (Sec. 18, T13N, R11W)





Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991
uR/hr

West	South	Waist	Ground
0	0	30	125
-1	Ō	20	20
<del>-</del> 2	Ö	23	23
-2 -3 -4	ŏ	19	21
-4	Ŏ	24	. 20
<b>-</b> 5	ő	24	48
<del>-</del> 6	0	28	28
-7	0	68	70
-8			
-8 -9	0	25	25
	0	23	23
-10	0	20	20
-11	0	25	28
-12	0	41	56
-13	0	28	23
-14	0	44	55
-15	0	33	33
-16	0	48	95
-17	0	33	35
-18	0	20	18
0	-1	23	24
-1	-1	20	22
-2	-1	22	22
-3	-1	24	25
-4	-1	65	35
-2 -3 -4 -5	<del>-</del> 1	100	85
<del>-</del> 6	-1	50	55
<b>-</b> 7	<b>-</b> 1	25	22
-8	-1	27	32
<b>-</b> 9	-1	29	29
-10	-1	24	23
-10 -11	-1	24	
<del>-</del> 12	-1	65	25 60
-13	-1	31	27
-14	-1	65	65
-15	-1	27	26
-16	-1	50	60
-17	-1	36	40.
-18	-1	23	21
0	-2	115	200
-1	-2	46	29
-2	-2	90	75
<b>-</b> 3	-2	94	81
-3 -4 -5 -6 -7	-2 -2 -2 -2 -2 -2 -2 -2 -2 -2	31	33
-5	-2	29	26
<b>-</b> 6	-2	28	28
<del>-</del> 7	-2	81	125
-8	-2	25	23
<b>-</b> 9	-2	20	20
-10	-2	23	23
-11	-2	23	23

Nanabah-Vandever Site, Section 24 Pre-Remediation Survey, August, 1991 uR/hr

West	South	Waist	Ground
-12	-2	75 ⁻	94
-13		40	38
-14	_2 _2	55	45
<del>-</del> 15	-2	38	38
<b>-16</b>	-2	28	23
-17	-2	20	19
-18	-2 -2 -2 -2 -2 -3 -3 -3 -3 -3	18	16
0	_3	130	125
-1	-3	44	46
	-3	39	38
-2 -3 -4	-3	28	27
-3 -4	-3 -3	26	26
-5	_3	24	24
<del>-</del> 6	-3	25	24
-7	-3 -3	26	25
-7 -8	-3 -3	25	24
-8 -9	-3 -3	25 27	26
	-3		30
-10	-3	35	
-11	-3	39	40
-12	-3	90	115
-13	-3	46	44
-14	-3 -3	40	42
-15	-3	. 44	38
-16	-3	40	39
-17	-3	20	21
-18	<del>-</del> 3	16	17
0	-4	33	31
-1	4	30	26
-2	-4	29	29
-3	-4	31	31
-4	-4	31	35
<del>-</del> 5	-4	35	33
<b>-</b> 6	-4	25	<b>2</b> 5
-7	-4	28	28
-8	-4	30	30
-9	-4	29	29
-10	-4	31	31
-11	-4	54	54
-12	-4	90	95
-13	-4	65	65
-14	-4	155	230
-15	-4	30	29
-16	-4	25	25
-17	-4	18	18
-18	-4	18	18
0	<b>-</b> 5	24	25
-1	<b>-</b> 5	27	27
-2	<del>-</del> 5	30	31
-3	<del>-</del> 5	35	36
-4	<del>-</del> 5	41	39
-			

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991
uR/hr

West	South	Waist	Ground
<b>-</b> 5	<b>-</b> 5	33	30
-6	<b>-</b> 5	26	26
<del>-</del> 7	<del>-</del> 5	29	28
-8	. <del>-</del> 5	38	40
<b>-</b> 9	-5	41	40
-10	<b>-</b> 5	65	60
-11	<del>-</del> 5	80	130
-12	<b>-</b> 5	80	75
-13	<b>-</b> 5	90	85 85
<del>-</del> 14	<b>-</b> 5	135	180
<b>-15</b>	<b>-</b> 5	70	65
-16	<del>-</del> 5	50	40
-17	<del>-</del> 5	27	27
<del>-</del> 18	-5 -5	24	23
0	-5 -6	36	31
-1	<del>-</del> 6	33	29
<del>-</del> 2	<b>-</b> 6	80	90
<b>-</b> 3	<b>-</b> 6	46	44
-3 -4	<b>-</b> 6	33	30
<del>-</del> 5	<b>-</b> 6	28	28
<b>-</b> 6	<b>-</b> 6	31	31
<b>-</b> 7	<b>-</b> 6	34	35
<del>-</del> 8	<b>-</b> 6	31	31
<b>-</b> 9	<b>-</b> 6	30	30
-10	-6	75	75
-11	-6	100	140
-12	-6	95	120
-13	<b>-</b> 6	80	90
-14	-6	95	95
-15	-6	90	90
-16	<b>-</b> 6	36	34
-17	<del>-</del> 6	29	28
-18	<del>-</del> 6	20	21
0	<del>-</del> 7	36	36
-1	<b>-7</b>	32	33
~2	<b>-</b> 7	31	31
-3	-7	30	29
-4	<del>-</del> 7	39	37
<del>-</del> 5	<del>-</del> 7	50	40
<b>-</b> 6	<b>-</b> 7	60	40
<del>-</del> 7	<del>-</del> 7	50	50
<del>-</del> 8	<del>-</del> 7	80	100
<del>~</del> 9	<del>-</del> 7	65	75
-10	<del>-</del> 7	40	41
-11	-7	35	34
-12	-7	40	35
-13	-7	55	50
-14	-7	140	210
-15	<del>-</del> 7	27	28
-16	<b>-</b> 7	29	28

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West	South	Waist	Ground
	_		2.2
-17	<b>-7</b>	30	30
-18	-7	25	26
0	-8	46	55
-1	-8	30	31
-2	<del>-</del> 8	30	30
-3	-8	29	. 29
-4	-8	29	28
-5	-8	50	50
-6	-8	80	80
<del>-</del> 7	-8	90	90
-8	-8	115	90
-9	<b>-</b> 8	100	165
-10	-8	35	35
-11	<del>-</del> 8	45	45
-12	-8	39	38
-13	<del>-</del> 8	150	150
-14	-8	33	31
-15	-8 -8	50	56
<b>-16</b>	-8	25	28
		35	
-17	-8		28
-18	-8	31	38
0	-9	32	41
-1	<b>-</b> 9	35	34
-2	-9	34	34
-3	<del>-</del> 9	32	31
-4	<del>-</del> 9	31	30
<del>-</del> 5	-9	33	32
-6	-9	40	38
-7	<b>-</b> 9	30	60
-8	<b>-</b> 9	125	165
-9	<b>-</b> 9	100	90
-10	<del>-</del> 9	50	39
-11	<b>-</b> 9	65	60
-12	<del>-</del> 9	95	120
-13	<b>-</b> 9	80	85
-14	<del>-</del> 9	65	70
-15	<del>-</del> 9	45	35
-16	<b>-</b> 9	50	45
-17	-9	60	60
-18	<b>-</b> 9	55	55
0	-10	36	36
-1	-10	38	36
-2	-10	35	35
-3	-10 -10	40	33
-4	-10 -10	95	75
-4 -5	-10 -10	36	36
<del>-</del> 5 -6	-10 -10	39	29
-7			46
	<b>-10</b>	44	
-8	-10	90	90
<del>-</del> 9	-10	95	90
		•	

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West	South	Waist	Ground
-10	-10	65	50
-11	-10	75	95
-12	-10	40	31
-13	-10	100	115
-14	-10	40	40
<del>-</del> 15	-10	29	29
<del>-</del> 16	-10	25	23
-17	-10	48	60
-18	-10	45	60
0	-11	45	40
-1	-11	60	50
-2	-11	45	40
-3	-11	65	50
-4	-11	90	90
<del>-</del> 5	-11	60	55
-6	-11	60	55
<b>-7</b>	-11	125	155
-8	-11	65	50
<b>-</b> 9	-11	90	80
-10	-11	130	130
-11	-11	65	65
-12	-11	33	33
-13	-11	29	29
-14	-11	230	275
<b>-1</b> 5	-11	22	22
-16	-11	20	20
-17	-11	20	19
-18	-11	18	19
0	-12	39	39
-1	-12	46	46
-2	-12	46	34
-3	-12	114	93
<b>-4</b> .	-12	200	214
<b>-</b> 5	-12	171	200
<b>-</b> 6	-12	93	86
<b>-7</b>	-12	114	129
-8	-12	49	43
-9	-12	186	171
-10	-12	214	243
-11	-12	86	57
-12	-12	31	29
-13	-12	29	26
-14	-12	26	23
<b>-1</b> 5	-12	19	17
-16	-12	17	17
-17	-12	17	17
-18	-12	14	14
0	-13	39	40
-1	-13	65	55
-2	-13	45	50
		•	

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West	South	Waist	Ground
-3	-13	150	700
-4	-13	110	90
<del>-</del> 5	-13	190	200
-6	-13	175	200
<del>-</del> 7	-13	95	90
<del>-</del> 8	-13	85	. 75
-9	-13	190	185
-10	-13	110	115
-11	-13	30	29
-12	-13	29	29
-13	<del>-</del> 13	22	22
-14	-13	20	20
-15	-13	19	19
0	-14	100	86
-1	-14	46	49
-2	-14	100	86
-3	-14	100	86
-4	-14	171	143
<del>-</del> 5	-14	314	229
-6	-14	271	214
<del>-</del> 7	-14	171	164 51
-8	-14	60 143	157
-9 <del>-</del> 10	-14 -14	46	51
-10 -11	-14 -14	171	214
<del>-</del> 12	-14 -14	29	29
-12 -13	-14	23	23
-14	-14	20	20
<b>-15</b>	-14	20	20
0	<b>-15</b>	75	75
-1	<b>-</b> 15	55	50
-2	<b>-</b> 15	65	75
<del>-</del> 3	<b>-1</b> 5	85	85
-4	-15	165	165
<b>-</b> 5	-15	160	<b>15</b> 5
-6	<del>-</del> 15	145	140
<del>-</del> 7	<b>-1</b> 5	84	86
-8	<b>-1</b> 5	47	42
<del>-</del> 9	<b>-1</b> 5	46	40
-10	<del>-</del> 15	38	34
-11	<del>-</del> 15	28	48
-12	<del>-</del> 15	22	22
-13	-15	20	20
-14	-15	18	18
-15	-15	18	18
0	-16	86	86
-1	-16	54	50
-2	-16	100	114
-3	-16	171	264
-4	-16	200	229

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West	South	Waist	Ground
<b>-</b> 5	-16	114	93
<del>-</del> 6	-16	107	114
-7	<b>-1</b> 6	171	200
-8	-16	79	54
<del>-</del> 9	<b>-</b> 16	40	· 36
-10	-16	40	40
-11	-16	46	34
-12	-16	29	23
-13	-16	20	20
0	-17	38	39
-1	-17	70	110
-2	-17	95	80
-3 -4	<b>-17</b>	100 70	115 55
-4 -5	-17 -17	70 85	85
<del>-</del> 5	-17 -17	135	150
<del>-</del> 7	-17 -17	100	85
<b>-</b> 8	<b>-17</b>	50	50
<b>-</b> 9	-17	55	55
-10	<b>-17</b>	50	50
-11	-17	39	31
-12	-17	23	21
-13	-17	18	18
0	-18	40	40
-1	<del>-</del> 18	100	86
-2	-18	214	257
-3	-18	371	600
-4	-18	100	93
<del>-</del> 5	-18	100	93
-6	-18	157	171
<b>-</b> 7	-18	271	286
<del>-</del> 8 <del>-</del> 9	-18 -18	57 37	50 31
-10	-18	40	49
-10 -11	-18	114	100
-12	-18	29	23
-13	-18	20	19
ő	<b>-</b> 19	38	38
-1	-19	125	130
- <u>2</u>	-19	100	90
<b>-3</b>	-19	95	90
-4	<del>-</del> 19	65	65
<b>-</b> 5	-19	65	70
<b>-</b> 6	-19	125	125
<del>-</del> 7	<b>-</b> 19	85	105
-8	-19	85	100
<b>-9</b>	-19	31	30
-10	-19	28	. 28
-11	-19	25	24
-12	<b>-</b> 19	22	23

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West	South	Waist	Ground
-13	-19	19	19
0	<b>-20</b>	100	86
-1	-20	129	207
-2	-20	129	150
-3	-20	86	· 79
-4	-20	100	86
<b>-</b> 5	-20	86	71
-6	-20	20	19
<b>-</b> 7	<del>-</del> 20	114	114
-8	-20	54	60
<del>-</del> 9	<b>-</b> 20	29	29
0	-21	70	55
-1	-21	80	120
-2	-21	110	115
-3	-21	70	65
-4	-21	44	46
<del>-</del> 5	-21	65	65
<del>-</del> 6	-21	90	85
<b>-</b> 7	-21	48	46
-8	-21	60	60
<b>-</b> 9	-21	27	25
0	-22 -22	36 49	31 40
-1 -2	-22 -22	57	100
-3	-22	46	51
-3 -4	-22 -22	31	29
- <del>-</del> 5	-22 -22	93	157
<del>-</del> 6	-22	37	34
<b>-</b> 7	-22	40	37
<b>-</b> 8	-22	107	93
<b>-</b> 9	-22	29	26
Ō	-23	37	34
-1	-23	35	34
-2	-23	30	29
<del>-</del> 3	<del>-</del> 23	30	30
-4	<del>-</del> 23	29	28
<del>-</del> 5	-23	55	50
-6	<b>-2</b> 3	45	38
<b>-</b> 7	-23	75	135
<del>-</del> 8	<b>-23</b>	29	31
<del>-</del> 9	<b>-23</b>	25	24
0	-24	37	34
-1	-24	29	26
-2	-24	29	27
-3	-24	46	46
-4	-24	51	37
<b>-</b> 5	-24 -24	31	31 31
-6 -7	-24 -24	34 34	31 29
<del>-</del> / -8	-24	20	29
-0	24	20	20

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			uk/III
West	South	Waist	Ground
<b>-</b> 9	-24	21	20
Ō	-25	26	26
-1	-25	27	28
<u>-2</u>	-25	26	24
-3	<b>-2</b> 5	30	32
-4	<b>-25</b>	27	26
<b>-</b> 5	<b>-25</b>	23	21
<del>-</del> 6	-25	21	20
<b>-</b> 7	-25	22	21
<del>-</del> 8	-25	19	17
<b>-</b> 9	-25	16	15
ó	-26	23	23
-1	-26	23	23
-2	-26	23	23
<del>-</del> 3	-26	23	23
-4	-26	23	23
<b>-</b> 5	-26	20	20
-6	-26	20	20
<b>-</b> 7	-26	20	17
<del>-</del> 8	-26	14	14
_	<del>-</del> 26	14	14
0	-27	20	19
-1	-27	21	20
-2	-27	22	21
<b>-</b> 3	-27	25	23
-4	-27	22	22
<del>-</del> 5	-27	23	23
-6	<b>-</b> 27	21	22
<b>-7</b>	-27	20	18
~8	<del>-</del> 27	33	22
-9	<del>-</del> 27	15	14
-4.5	<del>-</del> 0.5	86	60
-5.5	-0.5	86	60
<del>-</del> 6.5	-0.5	86	60
-13.5	-0.5	71	50
-2.5	-1.5	114	80
-3.5	-1.5	114	80
-4.5	-1.5	129	90
-11.5	-1.5	100	70
-12.5	-1.5	114	80
-13.5	-1.5	71	50
-0.5	-2.5	157	110
-1.5	-2.5 -2.5	100 114	70 80
-2.5 -11 5	-2.5 -2.5	100	70
-11.5 -12.5	-2.5 -2.5	107	76 75
-12.5 -9.5	-2.5 -3.5	86	60
-9.5 -11.5	-3.5 -3.5	100	70
-9.5	-4.5	86	60
-10.5	-4.5	100	70
10.0	4.5	100	, 0

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West	South	Waist	Ground
-14.5	-4.5	157	110
<del>-</del> 7.5	-6.5	57	40
-9.5	-6.5	43	30
-13.5	-6.5	86	60
-14.5	-6.5	100	70
-4.5	<del>-</del> 7.5	79	55
<del>-</del> 5.5	<b>-7.5</b>	79	55
<del>-</del> 6.5	<b>-7.</b> 5	114	80
<del>-</del> 7.5	<del>-</del> 7.5	157	110
-8.5	<del>-</del> 7.5	100	70
-9.5	-7.5	71	50
-11.5	-7.5	57	40
-13.5	-7.5	100	70
-14.5	-7.5	57	40
-5.5	-8.5	79	55
-7.5	-8.5	121	85
-8.5	-8.5	129	90
<b>-9.5</b>	-8.5	57	40
-11.5	-8.5 -9.5	86	60 70
-12.5 -13.5	-8.5 -8.5	100 57	70 40
-13.5 -14.5	-8.5 -8.5	43	30
-14.5 -3.5	-9.5	71	50 50
-6.5	-9.5 -9.5	50	35
<del>-</del> 7.5	-9.5	50	35
-8.5	-9.5	121	85
-9.5	<del>-</del> 9.5	46	32
-10.5	-9.5	71	50
-11.5	<del>-</del> 9.5	86	60
-0.5	-10.5	100	70
-1.5	-10.5	100	70
-2.5	-10.5	71	50
-3.5	-10.5	93	65
-4.5	-10.5	57	40
-5.5	-10.5	43	30
-6.5	-10.5	114	80
<b>-7.</b> 5	-10.5	143	100
-8.5	-10.5	129	90
<del>-</del> 9.5	-10.5	114	80
-13.5 -14.5	-10.5	286	200
-14.5 -0.5	-10.5 -11.5	286 43	200 30
-0.5 -1.5	-11.5 -11.5	57	
-1.5 -2.5	-11.5	129	40 90
-3.5	<del>-</del> 11.5	186	130
-4.5	-11.5	71	50
-5.5	-11.5	57	40
<b>-6.5</b>	-11.5	50	35
-8.5	-11.5	129	90
-9.5	-11.5	164	115

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West	South	Waist	Ground
-10.5	-11.5	71	50
-13.5	-11.5	286	200
-14.5	-11.5	286	200
-17.5	-11.5	57	40
-1.5	-12.5	57	40
-2.5	-12.5	186	130
-3.5	-12.5	154	108
-7.5	-12.5	143	100
-8.5	-12.5	171	120
-9.5	-12.5	164	115
-11.5	-12.5	57	40
-0.5	-13.5	43	30
-1.5	-13.5	179	125
-3.5	<del>-</del> 13.5	171	120
-5.5	<del>-</del> 13.5	186	130
-6.5	-13.5	371	260
-7.5	-13.5	371	260
-9.5	<del>-</del> 13.5	93	65
-10.5	-13.5	114	80
-11.5	-13.5	100	70
-2.5	-14.5	243	170
-3.5	-14.5	200	140
-4.5	-14.5	229	160
<del>-</del> 5.5	-14.5	271	190
<del>-</del> 6.5	-14.5	171	120
<del>-</del> 9.5	-14.5	114	80
-0.5	<del>-</del> 15.5	1714	1200
-1.5	<del>-</del> 15.5	514	360
-2.5	<del>-</del> 15.5	486	340
-3.5	-15.5	314	220
-4.5	<del>-</del> 15.5	286	200
-5.5	-15.5	343	240
-6.5	-15.5	857	600
-7.5	-15.5	243	170
-8.5	-15.5	186	130
-10.5	-15.5	514	360
-2.5	-16.5	240	
-3.5	-16.5	410	
-6.5	-16.5	750	
<del>-</del> 7.5	-16.5	175	
-10.5	-16.5	300	500
-0.5	-17.5	714	500
-1.5	-17.5	714	500
-2.5	-17.5	343	240
-3.5 -4.5	-17.5	1429	1000
<b>-4.</b> 5	-17.5 -17.5	186	130
-5.5 -6.5	-17.5	1143	800 375
	-17.5 -17.5	536	375
-7.5 -8.5	-17.5 -17.5	286 314	200 220
-0.5	-11.5	314	220

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West	South	Waist	Ground
-9.5	-17.5	286	200
-10.5	-17.5	286	200
-11.5	-17.5	500	350
-0.5	-18.5	430	
-1.5	-18.5	250	,
-3.5	-18.5	2300	
-4.5	-18.5	900	•
-5.5	-18.5	850	
-6.5	-18.5	1000	
-7.5	-18.5	1200	
-11.5	-18.5	210	
-0.5	-19.5	429	300
-1.5	-19.5	857	600
-2.5	-19.5	371	260
-4.5	-19.5	200	140
-5.5	-19.5	1357	950
-6.5	-19.5	357	250
-8.5	-19.5	286	200
-2.5	-20.5	175	
-7.5	-20.5	210	
-8.5	-20.5	1000	
-0.5	-21.5	600	420
-1.5	-21.5	1429	1000
-2.5	-21.5	200	140
-4.5	-21.5	186	130
-8.5	-21.5	257	180
-1.5	-22.5	950	
-7.5	-22.5	1700	
-6.5	-23.5	514	360
-2.5	-24.5	125	
	Avg Gamma	118.16	uR/hr

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West	North	Waist	Ground
-4	0	33	26
-3 -2 -1	Ö	100	120
-2	0	30	32
-1	0	32	31
0	0	75	60
-4 -3 -2	1	32	27
<del>-</del> 3	1	33	32
-2	1	33	32
-1	1	40	42
0	1	125	120
1 2 -4 -3 -2 -1		40	40
2	1	30	26
-4	2	25	25
<del>-</del> 3	2	28	28
-2	2	38	35
-1	2	60	55
0	2	100	145
1	2	75	60
2	2	42	44
1 2 3 4	2	30	27
4	2	24	24
-4	3	25	25
-3	3	60	60
-2 -1	<i>ა</i>	80	115 75
-4 -3 -2 -1 0 1 2 3 4 5 -4 -3 -2	1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3	85 130	140
1	3	70	60
7	ے ع	100	110
2	3	110	85
Δ	3	38	28
5	3	27	25
-4	4	60	75
-3	4	65	75
-2	4	95	100
-1	4	110	125
ō	4	65	50
0 1	4	105	105
	4	110	120
3	4	280	350
4	4	300	370
5	4	32	32
-4	5	38	29
<b>-</b> 3	5	35	38
2 3 4 5 -4 -3 -2 -1 0 1 2 3 4	4555555555555	65	55
-1	5	85	75
0	5	42	42
1	5	55	55 70
2	5	70	70
3	ב	420	600 80
4	5	170	80

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West	North	Waist	Ground
-4	6	22	21
-3	6	24	25
-2	6	75	65
-1	6	70	105
ō	6	, 5 75	70
1	6	115	120
2	6	100	115
2	6	250	240
1 2 3 4	6	280	300
<u> </u>	6	380	500
5 -4	7		23
<del>-</del> 3	7	23	25 26
-3 -2	7	26 85	85
-2 -1			
	7	550	600
0	7	850	800
1 2 3	7	380	450
2	7	90	95
3	7	270	290
4	7	250	330
5 -4	7	240	250
-4	8	22	21
-3 -2	8	25	26
-2	8.	80	75
-1	8	350	380
0	8	170	125
1 2 3 4	8	80	65
2	8	100	115
3	8	80	80
4	8	130	100
5 -4	8	60	50
-4	9	21	21
-3 -2	9	24	25
-2	9	27	26
-1	9	38	39
0	9	36	38
1 2	9	70	90
2	9	240	300
3	9	160	220
4	9	200	200
5	9	40	36
-4	10	19	19
-3	10	25	24
5 -4 -3 -2	10	25	23
-1	10	28	28
0	10	34	33
1	10	65	50
2	10	280	350
3	10	130	130
0 1 2 3 4	10	160	170
5	10	32	32
_			<del></del>

Brown-Vandever Site, Section 18
Pre-Remediation Survey, August, 1991
uR/hr

	•		
West	North	Waist	Ground
-4	11	19	19
-3	11	20	20
-4 -3 -2	11	20	20
-1	11	25	25
	11	37	36
, <b>1</b>	11	150	160
2	11	36	30
0 1 2 3 4	11	210	250
4	11	75	50
-4	12	19	18
-4 -3 -2 -1	12	19	19
-2	12	20	20
-1	12	22	23
0	12	29	27
0 1 2 3 4	12	26	25
2	12	50	50
3	12	24	24
4	12	25	24
-4	13	18	17
-3	13	19	19
-4 -3 -2 -1	13	19	18
-1	13	20	19
0	13	24	22
1	13	24	22
2	13	24	20
3	13	18	16
4	13	22	20
0 1 2 3 4 6 6	6	40	32
6	7	35	30
<del>-</del> 5	5	20	21
	Avg Gamma	92.05	uR/hr

Desiderio Site
Pre-Remediation Survey, August, 1991
uR/hr

South	West	Waist	Ground
19	34	30	50
18	36	20	30
15.5	34.5	10	10
15	37	30	
14.5	39	100	200
14.5	40	10	20
13	41	200	500
12	41	200	400
5.5	34.5	200	380
5.25	34.25	200	400
5	34.1	300	500
4.6	33.7	300	500
4	33.8	500	800
11	36	10	50
12	36	500	500
12	36.8	170	200
12	37.5	250	600
12	39	310	1000
12	40	40	48
12.7	39	110	250
12.7	37	180	400
12.7	36.1 34.5	130	110
12.7 13.5	34.5	310 100	380 130
13.5	30	100	110
13.8	30	80	80
11.5	29.5	130	130
11	32	250	800
11.5	33	110	110
10	28.6	300	1500
6	26.8	250	500
6.9	26.8	400	3000
7.3	26.3	300	300
6.8	25.9	50	50
5.8	25.9	30	30
5	25	25	25
5.2	22.5	28	28
6	21	20	20
7	20	30	30
7.5	19	32	32
9	19	120	300
9.1	17.9	50	50
10	18	50	50
10.5	18.1	100	800
10.5	18.9	50	50 3.5
10 9.2	19.4 20.3	35 35	35 35
9.2	19.8	30	30
8.4	20.4	30	30
8.6	21.1	38	38
0.0	21+1	36	50

Desiderio Site
Pre-Remediation Survey, August, 1991
uR/hr

South	West	Waist	Ground
6.9	22.5	30	30
6.7	24.3	50	50
6.8	25.1	80	80
7.1	25.1	110	170
11.1	22.5	100	100
11.2	21	150	150
12.8	19.9	100	100
13.3	18.2	110	110
16.2	25.5	100	300
16.5	25.3	350	
15.5	24	330	150
16.5	23.3	350	200
14.3	22.3	35	35
14	21.5	50	50
13.3	23.3	100	100
14	21	50	50
12.5	21.9	75	75
13	20.5	135	140
13.6	20.5	65	65
14	16.5	600	2000
7.7	17.5	24	24
5.4	14.1	35	35
5.8	13.9	50	70
5.2	13.6	35	35
4.9	13.2	35	35
4.1	11.7	28	28
4.8	11.7	25	25
3	9.2	60	500
3.3	7.9	40	70
3.8	8	60	100
4.2	9.5	35	35
4.5	7.2	35	35
7.3	7.1	50	50
7.8	6.9	50	400
8.5	5.6	35	35
9.2	5.3	40	75
9.5	5.2	50	50
10	5	65	750
11.5	6	30	30
11.85	6.5	75	300
9.9	6.6	45	45
9.2	7.5	50	50
8.7	7.8	75	75
7	7.8	45	45
6.3	8	35	35
7.4	9.2	50	50
6.2	9.4	50	50
5.3	10	130	1000
4.8	9.3	35	35
25	26.2	23	

Desiderio Site Pre-Remediation Survey, August, 1991 uR/hr

South	West	Waist	Ground
24.5	25.9	23	
24	26	29	
23.8	25.1	36	
24.1	25.1	43	
21.2	25.9	86	•
19.1	25.9	43	
18	26.1	107	
17.4	25.5	129	
17.6	24.7	200	
18.8	25.1	114	
17.3	23.2	43	
20.2	24.8	100	
20.8	24.2	100	
21.5	23.9	40	
22.8	23.3	43	
22.4	22.5	107	
22	22.5	157	
21.3	22.5	171	
22	23	157	
20.9	23	34	
21.1	22.1	114	
21.7	22	114	
22.2	22	129	
23.1	22	71	
23.7	23.2	21	
22.9	21.1	114	
22.5	21.4	171	
21.8	22.2	157	
21	21.6	86	
20.4	22.2	34	
20.3	23.1	34	
19.9	22.9	34	
19.2	23.9	37	
18.5	23.3	34	
18	22.6	34	
18	23.5	34	
21	25.2	43	
22.3	24.3	46	
22.5	20.6	31	
20.3	21	143	
20.2	21.5	157	
20	21.2	31	
18.7	21.3	29	
17	21.6	40	
16.6	22.4	57	
15.5	21.6	343	
15	21.6	86	
16.7	21	86	
17	20.6	186	
17.1	20.2	214	

Desiderio Site
Pre-Remediation Survey, August, 1991
uR/hr

South	West	Waist	Ground
17	19.4	157	
17.7	19.5	37	
18.7	20.6	29	
18.4	19.6	31	
19.3	17.3	29	•
20.1	18.1	114	
20.2	18.6	200	
20.8	18.5	314	
21.3	18.9	271	
20.2	19.1	286	
20.6	19.5	143	
20.1	19.5	143	
21.6	18.6	236	
21.2	17.7	300	
20.7	17.6	200	
21.7	18.1	200	
21.4	17.6	214	
21.7	18	157	
21.8	17.8	26	
21.7	18.9	193	
21.9	20	26	
20.2	15.1	26	
18.6	14	49	
18	14.5	100 29	
18.3 17.8	16.1 17	46	
17.6	18.5	186	
17	18.8	157	
16.7	18.3	143	
17	18.5	143	
17.1	17.8	329	
16.5	17.3	171	
16	18.5	343	
15.7	18	314	
15.5	18.6	214	
15.3	19.1	214	
16.4	19	186	
16.5	19.4	214	
16	19.3	214	
16.2	20	229	
15.5	20.2	221	
14.8	19.6	214	
17	17	129	
15.6	16.5	357	
14.9	16.1	629	
15.3	15.1	1143	
14.8	13.8	429	
16	13.4 12	1000 429	
16.7		429 71	
14.2	15.2	71	

Desiderio Site Pre-Remediation Survey, August, 1991 uR/hr

			uR/hr
South	West	Waist	Ground
15	12.5	314	
15	11.6	100	
14.8	10.8	314	
16.3	11	571	•
18.2	10	37	•
19.6	8.8	300	
20	10	286	
20.3	11.1	186	
20.7	12	214	
22	10	21	
18	6.8	26	
16.9	4.5	24	
15.3	6.2	100	
15.1	7.2	157 51	
16.2	9.1 8.5	214	
15.6 14.7	9.5	66	
12.5	6.2	31	
13.9	4.9	129	
14.7	4.7	200	
14.2	3.6	114	
11.2	4	57	
11.9	2.1	86	
13.5	3	121	•
11.2	1.1	64	
13	0.6	37	
14.6	0.8	23	
10	2	30	
9.3	0.6	23	21
23.8	30.7 28.3	21 29	21 29
22.9 22	28.3	43	43
21.6	28.7	43	57
21.9	29.6	21	21
21.6	31.9	43	43
20	32	29	29
19.7	30	71	71
20.4	28.3	143	371
21	27	257	371
22.8	27.1	71	71
22	26.3	100	186
21	26.2	171	329
19.7	26.4	71	71
19.2	27.7	34	34
19.2	29	43 29	26 29
19.1	30.9 32.9	29 29	29 31
19.3 20.5	32.9	29	20
17.7	30.5	29	26
16.6	29.2	29	34
10.0	23.2	23	34

Desiderio Site
Pre-Remediation Survey, August, 1991
uR/hr

			uk/III
South	West	Waist	Ground
18.2	28.5	29	29
16.7	28	26	26
15	28.1	46	40
14.4	27.3	43	37
13.9	27	71	71
14.4	26.2	54	57
15.7	27.2	69	46
15	27.3	97	114
12.6	26.8	214	457
12.8	25.1	71	71
12	25.8	43 71	34 71
11.2 11.5	25.7 26.6	143	143
11.9	24.3	46	40
10.4	25.5	214	429
9.5	25.5	143	186
10	26.5	186	214
7.1	26	200	171
8.9	26.8	86	71
9.2	24.8	214	171
11	24.4	457	2857
8.1	25.5	43	43
9.1	22.8	100	71
8.9	21.2	37	29
10.3	22.2	71	86
9.5	20.8	57	54
8.9	21.1	37	40
8 9.2	23.5 23.9	43 57	43 51
13.7	14.3	46	46
13.2	16.2	63	57
13.2	17.6	257	857
12.1	17.7	71	71
10.4	17.3	34	29
9.4	17.3	34	31
8.8	18.2	36	31
7.5	17.8	36	31
7.1	16.6	21	21
8.4	17.2	23	23
8.2	15.8	26	26
8.3	14.5	31	29
9.5	14.2	43	29
10	16	29	29
11	15.2 14.1	34 43	31 31
11.1 11.4	12.6	37	29
12.6	12.1	43	36
12.8	13.9	36	31
13.8	13.1	143	286
13.9	10.9	37	40
	2000	•	

Desiderio Site
Pre-Remediation Survey, August, 1991
uR/hr

South	West	Waist	Ground
12	9.8	66	79
11.5	9	186	371
10.3	8.2	57	36
9.7	9.6	143	100
8.2	11	257	257
8	12.3	286	514
7	12	343	457
6.4	13.8	34	34
9.5	12.9	243	286
10.2	12.1	429	543
10.5	11	229	157
11.2	9.8	51	34
12.5	10.3	36	34
13	8.5	86	200
10.6	7.5	49	39
9	8	429	3429
8.8	7.8	100	321
9.1	6.6	71	86
10.2	6.5	57	49
	Avg Gamma	122.93	uR/hr

## APPENDIX B

DUST GENERATION SUMMARY DURING RECLAMATION ACTION

Aerosol Particulate Monitoring at the Bluewater Uranium Mine Site

EPA Region IX, assisted by EPA/ERT and REAC is conducting a removal action at several areas of the Vandever and Desiderio mine sites near Prewitt, NM. As a result of earth moving operations to cover certain strip-mined areas, the potential exists for resuspension of higher than ambient concentrations of uranium and/or radium. From analysis of previous samples taken at these sites, using the maximum detected concentrations of each isotope, it was calculated that, for Class W lung retention and a 60 hour work week, a dust concentration of 170 micrograms per liter (ug/L) would result in a dose of 100 millirem per week (mrem/wk). In order to protect the workers, a criterion of "visible dust" was established for Level C respiratory protection. If "visible dust" (or, about 10 ug/L) is present, all unprotected personnel must go to Level C respiratory protection.

In order to better quantify dust concentrations present at locations of interest, a model RAM-1 real-time aerosol monitor was used. instrument, S/N 1727, calibrated at REAC on 7/28/91, was manufactured by (Monitoring Instruments for the Environment, Inc.) of Bedford, The RAM-1 is a portable, self-contained aerosol monitor Massachusetts. whose sensing principle is based on the detection of near-forward scattered infrared radiation. The instrument uses a gallium arsenide semiconductor which generates EM radiation at 940 nanometers (nm) wavelength. scattered radiation is detected by means of a silicon photo-voltaic type diode with an integral low-noise preamplifier. The instrument has three selectable ranges  $[0-2, 0-20, and 0-200 mg/m^3 (= ug/L)]$ . In addition, there are four operator-selectable response-time constants (0.5, 2, 8 and 32 seconds). The air flow-rate for sampling is 2 L/min, and for flushing with clean air is 0.2 L/min. After being fully charged, the instrument is designed to operate continuously for 6 to 8 hours.

The following table summarizes aerosol particulate data obtained at the Brown Vandever site (beginning 8/20/91), and at the Desiderio site

(beginning 9/3/91).

The response time constant for the measurements was usually 2 seconds. With the exception of the time a car passed within 4 feet of the instrument, the maximum airborne dust concentration measured was 0.371 ug/L. If breathed at that concentration continuously (60 hours per week) for a year with the maximum concentrations previously measured of uranium and radium, a 50-year committed effective dose equivalent (cede) of 10.9 mrem would result.

[cede = 
$$(5000/170) \times (C_{max}) = 29.41 C_{max}$$
]  

$$cede_{50 \text{ yr}} \text{ (mrem)} = 29.41 C_{max} \text{ (ug/L)}$$

where,

 $C_{max}$  = Dust Concentration in ug/L

Over the period from 08/20/91 through 09/17/91, a total of 41 dust concentration measurements for a total of 309 minutes were made on 18 different days at a variety of locations on the Vandever and Desiderio mine sites. The total time-weighted dust concentration over the entire study was .011 ug/L, which, if breathed continuously for 60 hours per week and 50 weeks per year at maximum previously-measured uranium and radium concentrations, would result in a committed effective dose equivalent (cede) of 0.32 mrem.

G. L. Gels 09/25/91

Table 1

		Table	<b>.</b> _	Meac	urement	Concentration
Date	_Time_	Location Z	ero C	al.		Range, ug/L
VANDEV			ero c	.01.	1 TIIIC	
08/20		HP checkpoint	000	2.50	5 min	to .006 ug/L
00/20	09:20	30-200 m N of dozers	000	2.50	3	to .007
	09:40	50-150 m N of dozers	004		3	.000 to .016
	11:45				2	
		HP cp, downwind	000			to .004
00/31	16:37	HP cp, upwind	000		3	.003 to .012
08/21	08:50	100-200m dnwnd of dzers			2	.006 to .012
	09:10	HD an	.002		3 4	.008 to .016
	10:50	HP cp	000			.003 to .006
	15:27	30-200 m dnwnd of dzers			5	.000 to .005
	15:49	HP cp	000		2	.000 to .006
	15:51	HP cp. Car passes-4 ft			0.5	.002 to .623
00/00	00.00	**************************************			_	to .003
08/22	09:00		000		5	.003 to .006
22/22	14:30	200-500 m S of dozers			10	.001 to .013
08/23	09:00	HP cp	000		6	.003 to .005
	14:32	нР ср	000		8	.003 to .005
08/24	08:59	HP cp, Sec 24, Brwn-Van	000	2.50	7	.001 to .007
						MIN MAX AVG
	09:17	75 m NW of dozer	000		12	.000 .023 .006
			to			
			004			
	09:40	SW sector of Sec 24	000	2.50	5	.002 .005 .003
08/26	08:58	HP cp	000	2.50	10	.008 .208 .012
	14:08	HP cp	000		4	.004 .013 .009
	15:43	HP cp VERY windy	001		8	.005 .371 .040
		(thunderstorm)				
08/28	13:20	HP cp	000	2.50	5	.002 .008 .005
DESIDE	RIO					
09/03	10:55	HP cp	000	2.50	5	.002 .004 .003
09/04	10:10	HP cp	000	2.50	5	.003 .006 .005
•	15:10	SW of pit	000		5	.000 .000 .000
	15:20	North side of NE pit	000		5	.003 .042 .022
09/07	17:05	HP cp	000		5	.010 .170 .026
09/09	15:30	HP cp, 25 m downwind	000		30	.003 .174 .030
•		of loader				
09/10	09:06	HP cp, dozer 75 m upwnd	000	2.49	10	.003 .015 .009
•	13:50	HP cp dozer near	000		12	.000 .058 .011
09/11	07:50	НР ср	000		10	.008 .011 .009
	15:25	НР ср	001		10	.002 .141 .004
09/12	08:25	НР ср	000		10	.004 .040 .008
	14:05	HP cp	000		10	.000 .071 .005
09/13	11:30	НР ср	000		15	.000 .015 .004
,	15:45	HP cp	000		10	.000 .006 .002
09/14	10:55	HP cp	000		7	.003 .006 .005
,	16:55	HP cp	000		5	.002 .004 .003
09/16	08:30	HP cp, dozer 100m upwnd			15	.003 .045 .010
, 10	13:40	HP cp, dozer 50-100 m	000		10	.003 .043 .010
		upwind			10	257 .035
09/17	11:15	HP cp	000	2.50	10	.004 .014 .008
00/11	14:35	HP cp	000		8	.002 .007 .005
	~ <del>-</del> • J J	<u>-</u> -	. 550		J	.002 .007 .005

Table 2
Bluewater Uranium
Average Dust Concentration Calculation

DATE	MEASUREMENT TIME (MIN)	AVG DUST CONC (ug/L)
08/20/91	5	0.004
00/20/51	5	
	3	0.005
	3	0.008
	2	0.003
		0.008
00/01/01	3	
08/21/91	2	0.009
	3	0.012
	5 3 2 3 2 3 4 5 2	0.005
	,	0.003
	ž	
00/00/01	2	0.003
08/22/91	5	0.005
	10	0.007
08/23/91	6	0.004
,,	8	0.004
00/24/01	7	0.005
08/24/91		
	12	0.006
	5	0.003
08/26/91	10	0.012
,,	4	0.009
	8	0.04
00/00/01		
08/28/91	5	0.005
09/03/91	5	0.003
09/04/91	5	0.005
• •	5	0
	5	0.022
00/07/01	5	0.026
09/07/91		
09/09/91	30	0.03
09/10/91	10	0.009
• •	12	0.011
09/11/91	10	0.009
03/11/31	10	0.004
00/10/01		
09/12/91	10	0.008
	10	0.005
09/13/91	15	0.004
	10	0.002
00/14/01	7	0.005
09/14/91		
	5	0.003
09/16/91	15	0.01
	10	0.035
09/17/91	10	0.008
,,	8	0.005
	•	0.005
momar	0.00	
TOTAL:	309	

AVERAGE TIME-WEIGHTED DUST CONCENTRATION: 0.01091

## Bluewater Uranium Mines Site

	<u>Maximum</u>	measured	concentrations	rem(lung)/u	<u>Ci of intake</u>
				Class W	<u>Class Y</u>
²³⁸ U:	390 j	pCi/g =	$3.9 \times 10^{-4} \text{ uCi/g}$	52	1000
²³⁵ U:	29	<b>35</b>	2.9 x 10 ⁻⁵	56	1000
²³⁴ U:	330	==	$3.3 \times 10^{-4}$	59	1100
²²⁶ Ra:	450	<del>200</del>	$4.5 \times 10^{-4}$	59	

If a person inhaled one gram (1 g) of dust at maximum measured concentrations, he would inhale:

3.9 x	10-4	uCi	of	²³⁸ U	leading	to	a	(50	yr)	lung	dose	of	.0203	rem
2.9 x				²³⁵ U	•			•					.0016	
3.3 x	10-4			²³⁴ U									.0195	
4.5 x	10-4			²²⁶ Ra	ı								.0266	
using	the	Class	s W	lur	ng retent	tio	2 2	facto	ors.					

Summing the doses from the four radionuclides gives a total lung dose per gram of dust inhaled of

.068 rem(lung)/g(dust)
Or, using a lung weighting factor of 0.12,
.0082 rem(cede)/g(dust)

or,

8.2 mrem(cede)/g(dust) [Class W]

Doing the same exercise for Class Y factors for the uranium isotopes, a person would inhale (per gram of dust):

```
3.9 x 10^{-4} uCi of ^{238}U leading to a (50 yr) lung dose of .390 rem 2.9 x 10^{-5} .029 3.3 x 10^{-4} .363 4.5 x 10^{-4} .225Ra .0266 using the Class Y lung retention factors.
```

Summing the doses from the four radionuclides gives a total lung dose per gram of dust inhaled of

.81 rem(lung)/g(dust)
Or, using a lung weighting factor of 0.12,
.097 rem(cede)/g(dust)

Or,

97 mrem(cede)/g(dust) [Class Y]

To keep the dose for the job below 100 mrem per 60 hr. week, or 1.67 mrem/hr, one could not breathe dust at a concentration greater than  $w_c$  (for Class W) or  $y_c$  (for Class Y), where

 $w_r = [1.67 \text{ mrem/hr}]/[8.2 \text{ mrem/g}] = .204 \text{ g/hr}$ 

and

 $y_r = [1.67 \text{ mrem/hr}]/[97 \text{ mrem/g}] = .0172 \text{ g/hr}$ 

So, at 20 L/min x 60 min/hr = 1200 L/hr, the dust concentration must be less than:

 $W_c = [.204 \text{ g/hr}]/[1200 \text{ L/hr}] = 1.7 \text{ x } 10^{-4} \text{ g/L} = 170 \text{ ug/L}$ 

and

 $y_c = [.0172 \text{ g/hr}]/[1200 \text{ L/hr}] = 1.43 \text{ x } 10^{-5} \text{ g/L} = 14.3 \text{ ug/L}$ 

These are the dust concentrations at which respiratory protection is required. This calculation is based upon the highest measured concentrations of each nuclide and the presence of the calculated dust concentrations for 60 working hours per week.

G. L. Gels
8/11/91

## APPENDIX C

POST RECLAMATION GAMMA SURVEY DATA SEPTEMBER, 1991

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-9 -10 -11 -12 -13 -14 -15 -16 -17 -18 -8	-1 -1 -1 -1 -1 -1 -1 -1 -1	30 20 18 18 15 20 18 27 18 18
-9 -10 -11 -12 -13 -14 -15 -16 -17 -18 -8	-2 -2 -2 -2 -2 -2 -2 -2 -2 -3	20 18 16 16 20 32 56 20 18 14 24
-8 -9 -10 -11 -12 -13 -14 -15 -16 -17 -18	-3 -3 -3 -3 -3 -3 -3 -3	24 28 27 20 18 18 30 30 21 14
0 -1 -2 -3 -4 -5 -6 -7 -8 -9	-4 -4 -4 -4 -4 -4 -4 -4	26 24 22 28 25 28 22 18 22 24
-10 -11 -12 -13 -14 -15 -16 -17	-4 -4 -4 -4 -4 -4	41 40 18 18 24 22 16 12

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-18 0	-4 -5	12 22
-1 -2	<b>-</b> 5 <b>-</b> 5	20 20
-2 -3	<del>-</del> 5	36
-4	<b>-</b> 5	20
-5 -6	<del>-</del> 5 <del>-</del> 5	22 24
<b>-</b> 7	<b>-</b> 5	36
-8 -9	<del>-</del> 5 <del>-</del> 5	46
-10	<del>-</del> 5	56 50
-11	<b>-</b> 5	22
-12 -13	-5 -5	24 20
-13 · -14	-5 -5	18
<b>-1</b> 5	<b>-</b> 5	20
-16 -17	<b>-</b> 5 <b>-</b> 5	14 12
-18	-5 -5	14
0	<b>-6</b>	24
-1 -2	-6 -6	20 20
-3	<b>-</b> 6	32
-4	<del>-</del> 6	24
<del>-</del> 5 <del>-</del> 6	-6 -6	23 26
-7	<del>-</del> 6	30
-8	<b>-</b> 6	24
-9 -10	-6 -6	34 42
-11	<b>-</b> 6	20
-12	<b>-</b> 6	34
-13 -14	<del>-</del> 6 <del>-</del> 6	22 20
-15	-6	20
-16	-6	14
-17 -18	-6 -6	12 14
0	<b>-</b> 7	23
-1	<del>-</del> 7	20
-2 -3	-7 -7	20 20
-4	<b>-</b> 7	20
<b>-</b> 5	<b>-</b> 7	26
-6 -7	-7 -7	40 30
-8	<b>-7</b>	36
<del>-</del> 9	<b>-</b> 7	24
-10	<del>-</del> 7	38

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-4	-10	24
<b>-</b> 5	-10	38
<del>-</del> 6	-10	50 26
-7 -8	-10 -10	26 28
-8 -9	-10 -10	30
-10	-10	38
-11	-10	32
-12	-10	36
-13	-10	20
-14	-10	18
<b>-1</b> 5	<b>-10</b>	20 42
-16 -17	-10 -10	32
-17 -18	-10 -10	34
0	-11	26
-1	-11	24
-2	-11	20
<del>-</del> 3	-11	26
-4	-11	32
<del>-</del> 5	-11	46
<del>-</del> 6	-11 -11	40 40
-7 -8	-11 -11	32
<del>-</del> 9	-11	56
-10	-11	36
-11	-11	22
-12	-11	20
<b>-1</b> 3	-11	18
-14	-11	24
<b>-15</b>	-11 -12	20 26
0 <b>-1</b>	-12 -12	22
- <u>1</u> -2	-12 -12	22
<b>-</b> 3	-12	30
-4	-12	32
<b>-</b> 5	-12	46
<del>-</del> 6	-12	46
<b>-</b> 7	-12	36
-8	-12 -12	50
-9 -10	-12 -12	44 32
-10 -11	-12	20
-12	-12	18
-13	-12	14
0	-13	26
-1	-13	26
-2	-13	24
-3	-13	26
-4	-13	24

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-5	-13	44
-6	-13	55
-7	-13	50
-8	-13	36
-9	-13	34
-10	-13	36
-11	-13	20
-12	-13	22
-13	-13	14
0	-14	42
-1	-14	28
-2	-14	44
-3	-14	28
-4	-14	44
-5	-14	30
-6	-14	44
-7	-14	56
-8	-14	32
-9	-14	22
-10	-14	16
-11	-14	22
-12	-14	20
-13	-14	16
0	-15	55
-1	-15	26
-2	-15	36
-3	-15	23
-4	-15	50
-5	-15	56
-6	-15	50
-7	-15	50
-8	-15	42
-9	-15	30
-10	-15	28
-11	-15	26
-12	-15	18
-13	-15	14
0	-16	32
-1	-16	26
-2	-16	44
-3 -4 -5 -6 -7	-16 -16 -16 -16 -16	24 56 50 46
-7	-16	40
-8	-16	24
-9	-16	26
-10	-16	20
-11	-16	14
-12	<b>-</b> 16	14

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-13	-16	12
0	-17	32
<b>-1</b>	-17 -17	30
- <u>1</u>	-17 -17	40
-3	-17 -17	24
<b>-4</b>	-17 -17	. 36
- <del>-</del> 5	-17 -17	55
<del>-</del> 6	-17 -17	50
-7	-17 -17	40
<b>-8</b>	-17 -17	34
-9	-17 -17	24
-10	-17 -17	26
-11	-17 -17	16
-12	-17	16
-13	-17	10
0	-18	22
-1	-18	32
-2	<del>-</del> 18	38
-3	-18	26
-4	-18	48
<del>-</del> 5	<b>-18</b>	56
<del>-</del> 6	<del>-</del> 18	56
-0 -7	<b>-18</b>	50
<del>-</del> 8	-18	24
<b>-</b> 9	-18	18
-10	-18	20
-11	<b>-18</b>	18
-12	<del>-</del> 18	12
0	<b>-19</b>	26
-1	<del>-</del> 19	50
-2	<b>-1</b> 9	30
-3	<b>-19</b>	42
-4	-19	46
<del>-</del> 5	<del>-</del> 19	44
-6	-19	40
<b>-7</b>	<b>-1</b> 9	50
<del>-</del> 8	<b>-1</b> 9	22
<b>-9</b>	<b>-1</b> 9	18
-10	<del>-</del> 19	14
-11	<b>-1</b> 9	12
0	-20	80
-1	-20	30
-2	-20	34
-3	-20	22
-4	-20	32
<del>-</del> 5	-20	56
-6	-20	30
<b>-7</b>	-20	30
-8	-20	18
<del>-</del> 9	-20	16

Nanabah-Vandever Site, Section 24 Post-Remediation Survey, August, 1991

West	South	Waist uR/hr	
HESC	Bouth	dk/III	
0	-21	26	
-1	-21	26	
-2	<del>-</del> 21	36	
-2 -3	-21	20	
-4	-21	36	
<b>-</b> 5	-21	50	
-6	-21	30	
-7	<del>-</del> 21	24	
-8	-21	24	
-9	<b>-21</b>	14	
0	-22	24	
-1	-22	22	
-2 -3	-22	20	
-3	-22	22	
-4	-22	26	
-5	-22	24	
-6	-22	50	
-7	-22	34	
-8	-22	20	
<b>-</b> 9	-22 -23	14	
0 -1	-23 -23	28 28	
-1 -2	-23 -23	26 24	
-3	-23 -23	22	
-3 -4	-23 -23	34	
<del></del>	-23 -23	50	
<b>-</b> 6	<b>-23</b>	36	
<b>-</b> 7	-23	16	
<del>-</del> 8	-23	30	
<del>-</del> 9	-23	10	
	Avg Gamma	28.19 uR/hi	c

Brown-Vandever Site, Section 18
Post-Remediation Survey, August, 1991
uR/hr

West	North	Waist	Ground
			(Pre-response)
4	•	10	(Presionse)
-4	0	18	26 120
-3	0	12	120
-2	0	18	32
-1	Ō	10	31
0	0	20	60
-4	1	12	27
-3 -2	1	12	32
-2	1	15	32
-1		16	
	1	16	42
0	1	20	120
1	1	15	40
1 2		18	26
-4	- 2	12	25
-4	2		
<del>-</del> 3	2	12	28
-2	2	12	35
-1	2	16	<b>5</b> 5
0	2	14	145
1	1 2 2 2 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3		
1 2 3 4 5 -4	2	12	60
2	2	14	44
3	2	12	27
Δ	2	12	
-	ັ້	12	24
5	2	12	24
-4	3	10	25
<b>-</b> 3	3	20	60
-2	3	14	115
-1	3	10	75
	3		75
0 1 2 3 4	3	12	140
1	3	12	60
2	3	14	110
3	3	12	85
Ž	3		
4	3	12	28
5	3	14	
6	3	12	
5 6 <b>-</b> 5	-4	12	25
-4 -3 -2	4	12	75
3		16	
<del>-</del> 3	4	16	75
-2	4	12	100
-1	· 4	10	125
0	4	10	50
1	4 4	14	105
<u>.</u>	4	14	105
2	4	12	120
3	• 4	16	350
4	4	12	370
5	4	12	32
<u> </u>	A	14	<b></b>
0	4	14	
-4	5	18 12	29
<del>-</del> 3	5	12	38
-2	5	10	55
0 1 2 3 4 5 6 -4 -3 -2 -1 0	4 5 5 5 5 5	12	75
<b>~</b>	5	16	/ 5
U	5	12	42

# Brown-Vandever Site, Section 18 Post-Remediation Survey, August, 1991 uR/hr

West	North	Waist	Ground (Pre-response) 55
	=: == ===		(Pre-response)
1	5	12	55 (102)
2	5	14	70
1 2 3 4	5 5 5 5		600
3	5	14	600
4	5	12	80
5 -4	5	16	
-4	6	12	21
-3 -2	6	12	25
-2	6	10	65
-1	6	12	105
0	6	10	70
1	6	12	120
2	6	12	115
3	6	12	240
4	6	12	300
5	6	16	500
0 1 2 3 4 5 <del>-</del> 5	7	14	500
-: <u>-</u> :1	7		22
-4	7	12	23
-3	7	16	26
-2	7	34	85
-1	7	14	600
0	7 7	12	800
1	7	12	450
2	7	12	95
3	7	12	290
4	7	12	330 ·
0 1 2 3 4 5 -6 -5	7	12	250
<del>-</del> 6	8	14	
<del>-</del> 5	8	12	
-4	8	12	21
-3	8	12	26
-2	8 8	12	75
-1	. 8	16	380
ō ·	8		
1	8	10	125
7	8	12	65
2	8	12	115
3	8	12	80
1 2 3 4 5	. 8	12	100
_	. 8	12	50
-4	9	14	21
<b>-</b> 3	9	14 12 12 12	25
-2	9	12	26
-1	9	12	39
0	9	12	38
1	9	12	90
2	9	12	300
3	á	12	220
-4 -3 -2 -1 0 1 2 3 4 5 -4 -3	9 9 9 9 9 9 9	12 12 12 12 12 12	200
	٥	12	36
_1	10	10	19
<b>4</b>	10	10	
-3	10	12	24

Brown-Vandever Site, Section 18
Post-Remediation Survey, August, 1991
uR/hr

	-		
West	North	Waist	Ground
			(Pro-response)
-2	10	14	(fre-response)
-1	10	10	28
	10	12	33
1	10	12	50
0 1 2 3 4 5	10	12	350
3	10	12	130
4	10	12	170
5	10	18	32
-4	11	12	19
<b>-</b> 3	11	10	20
-2	11	12	20
-4 -3 -2 -1	11	12	25
0	11	14	36
1	11	12	160
2	11	10	30
1 2 3 4	11	14	250
4	11	12	50
-4 -3 -2	12	12	18
<del>-</del> 3	12	12	19
-2	12	12	20
-1	12	12	23
0 1 2 3 4	12	10	27
1	12	12	25
2	12	12	50
3	12	12	24
4	12	12	24
-4	13	12	17
-4 -3 -2	13	12	19
-2	13	12	18
-1	13	10	19
0	13	10	22
1	13	14	22
1 2 3 4	13	12	20
3	13	12	16
4	13	12	20
6	6	12	32
6	. 7 . 5	12	30
<b>-</b> 5	· 5	12	21

Avg Gamma 12.84 uR/hr

Desiderio Site Post-Remediation Survey, September, 1991

Pre-Remediation	on Grid		Post-Reme	diation Grid
South	West	Waist uR/hr	North	East
24.7	32.1	11	NO	EO
24.2	29.9	39	NO	<b>E1</b>
23.6	27.6	12	NO	E2
23.1	25.4	11	NO	E3
22.5	23.1	11	NO	<b>E4</b>
22.0	20.9	14	NO	<b>E</b> 5
21.4	18.6	14	NO	<b>E</b> 6
20.9	16.4	12	NO	E7
20.3	14.1	13	NO	 E8
19.8	11.9	13	NO	E9
19.2	9.6	13	NO	E10
18.7	7.4	15	NO	E11
22.4	32.6	17	N1	EO
21.9	30.4	13	N1	E1
21.3	28.1	14	N1	E2
20.8	25.9	12	N1	E3
20.3	23.7	12	N1	E4
19.7	21.4	15	N1	<b>E</b> 5
19.2	19.2	12	N1	E6
18.6	16.9	12	N1	E7
18.1	14.7	14 -	N1	E8
17.5	12.4	19	N1	E9
17.0	10.2	40	N1	E10
16.4	7.9	22	N1	E11
20.2	33.2	12	N2	EO
19.6	30.9	11	N2 N2	E1
19.1	28.7	13	N2	E2
18.5	26.4	17	N2	E3
18.0	24.2	13	N2	E4
17.4	21.9	12	N2 N2	E5
16.9	19.7	11	N2 N2	E6
16.3	17.4	12	N2 N2	E7
15.8	15.2	14	N2	E8
15.3	13.0	16	N2	E9
14.7	10.7	18	N2	E10
14.2	8.5	28	N2	E11
17.9	33.7	15	N3	EO
17.4	31.5	22	N3	E1
16.8	29.2	12	N3	E2
16.3	27.0	11	N3	E3
15.7	24.7	15	N3	E4
15.2	22.5	11	N3	E5
14.6	20.2	12	N3	E6
14.1	18.0	10	N3	E7
13.5	15.7	50	N3	E8
13.0	13.5	18	N3	E9
12.4	11.2	14	N3	E10
11.9	9.0	25	N3	E11
15.6	34.2	12	N4	EO
13.0	34.2	12	74.4	EU

Desiderio Site Post-Remediation Survey, September, 1991

Pre-Remediation Grid		Waist	Post-Remediation Grid	
South	West	Waist uR/hr	North	East
15.1	32.0	13	N4	<b>E</b> 1
14.5	29.7	13	N4	<b>E2</b>
14.0	27.5	12	N4	<b>E</b> 3
13.5	25.3	17	N4	<b>E4</b>
12.9	23.0	12	N4 ·	<b>E</b> 5
12.4	20.8	12	N4	<b>E</b> 6
11.8	18.5	11	N4	<b>E</b> 7
11.3	16.3	20	N4	<b>E</b> 8
10.7	14.0	30	N4	E9
10.2	11.8	30	N4	E10
9.6	9.5	14	N4	E11
13.4	34.8	12	<b>N</b> 5	EO
12.8	32.5	15	<b>N</b> 5	E1
12.3	30.3	13	N5	E2
11.7	28.0	14	<b>N</b> 5	<b>E</b> 3
11.2	25.8	11	N5	<b>E4</b>
10.6	23.5	12	N5	<b>E</b> 5
10.1	21.3	11	N5	<b>E</b> 6
9.5	19.0	14	<b>N</b> 5	<b>E</b> 7
9.0	16.8	18	N5	<b>E</b> 8
8.5	14.6	14	N5	E9
7.9	12.3	18	N5	E10
7.4	10.1	13	N5	E11
11.1	35.3	15	N6	EO
10.6	33.1	25	N6	E1
10.0	30.8	32	N6	E2
9.5	28.6	15	N6	<b>E</b> 3
8.9	26.3	11	N6	<b>E4</b>
8.4	24.1	12	N6	<b>E</b> 5
7.8	21.8	10	N6	<b>E</b> 6

Avg Gamma

15.86 uR/hr

## $\frac{\textbf{APPENDIX}}{\textbf{D}} \; \frac{\textbf{D}}{\textbf{ATSDR}} \; \textbf{POST} \; \textbf{RECLAMATION} \; \textbf{LETTER}$





Public Health Service Agency for Toxic Substances and Disease Registry

#### Memorandum

Date

September 24, 1991

From

William Q. Nelson, Senior Regional Representative, Region IX

**Subject** 

Review of Response Actions at the Bluewater Uranium Site

To

Robert Bornstein, EPA OSC/ERS, H-8-3, Rm 8155

The Agency for Toxic Substances and Disease Registry (ATSDR) has reviewed the draft and final document dated September 23, 1991, describing the past removal action summary of exposure for the above site.

In consultation with Dr. Paul Charp of ATSDR, we find that the described removal actions are satisfactory for those areas indicated and are protective of public health.

#### INDOOR RADON AT VANDEVER AND DESIDERIO MINE SITES

There is some concern about indoor radon concentrations at the Vandever and Desiderio uranium mine sites (the Bluewater Mine Sites) near Prewitt, New Mexico. Strip mining operations occurred at both of these locations in the past, indicating that relatively rich uranium deposits lie fairly close to the surface and in close proximity to the home sites.

Two questions need to be answered at these locations: (1) How do indoor concentrations measured at these two sites compare with concentrations measured elsewhere? And, (2) Is it either likely or possible that past mining operations have adversely affected the radon concentrations indoors?

To answer the first question, it has been reported that a concentration of 4.6 pCi/L has been measured at one of the homes at the Desiderio Site, as well as concentrations between 1.5 and 3.3 pCi/L at other homes on site. These measurements were taken with alpha track detectors left in place for two to three months. The results reported at the mine sites are typical for this area (IHS survey, January, 1990,) and in most areas of the country. In the immediate Bluewater area, thirteen homes were measured in the IHS survey, ranging from <1.0 to 7.5 pCi/L, with the average being 2.5 pCi/L. As another point of comparison, a survey in North Dakota showed average radon concentrations of about 6 pCi/L. The conclusion is that there seems to be nothing unusual about the results reported at the two mine sites.

Is it likely, or even possible, that past mining operations have affected indoor concentrations at these sites? The source of indoor radon is the soil in direct proximity to the home. The distance that radon can travel before it decays is directly related to the soil porosity and inversely related to the moisture content. The two mine sites contain a soil horizon composed of fine to coarse grain sand and weathered limestone. The soil porosity is high and the moisture content is low. Therefore, the soil possesses very good soil gas diffusion characteristics. However, since the mean diffusion path length for a radon atom is only a few meters at most before it decays, and since no mining operations have taken place within 50 meters of any on the homes, it is unlikely that the mining operations have in any way affected the soil gas radon concentrations near the homes.

Since these two sites are not "normal" sites as far as the potential for outdoor concentrations of radon, the additional question might be asked, "Could these homes be affected by airborne radon from nearby exposed uranium seams or open mine shafts?". It is difficult to answer "No" to such a speculative question, since outdoor concentration measurements have never been made to my

knowledge. However, it is very unlikely that increases in outdoor concentrations near the homes have occurred as a result of mining operations. The distance of the homes from any potential airborne sources plus the vast volume of mixing air between source and receptor support this conclusion. Indirectly, it must be noted that while radon soil gas measurements have been used as a prospecting tool, radon air concentration measurements have never been used to prospect for uranium. This indicates that increased air concentrations are not associated with rich uranium soil deposits, and thus one would not expect to see any increase in airborne radon concentrations near the homes on these sites.

In conclusion, it does not appear that any increased indoor radon concentrations should be expected or have been measured at the homes on the Vandever and Desiderio sites. Additional long-term measurements following EPA protocols may help clarify this conclusion. It is recommended that any new home construction, particularly on land included as part of this removal action, include piping and sub-foundation gravel consistent with EPA recommendations for new home construction, so that if elevated concentrations are encountered (as have been in 8.3% of the homes in the IHS study), mitigation procedures will be cheap and effective.

high

NAVAJO SUPERFIND PROGRAM

Manabah Kandever Si Report



## United States Department of the Interior

#### BUREAU OF LAND MANAGEMENT

Rio Puerco Resource Area 435 Montano N.E. Albuquerque, New Mexico 87107



IN REPLY REFER TO:

3570 (017)

JUL 07 19

The Navajo Nation

Attn: Louise Linkin, Navajo EPA

P.O. Box 308

Window Rock, AZ 86515

Dear Ms. Linkin:

At the request of Patrick Antonio, Roger Baer of my staff has prepared three work-maps for Patrick's use. These maps outline areas on Navajo allotted lands where the greatest possibility exists for finding residences which have high levels of radioactive radon-222 gas.

Uranium mineralization has historically been found in all rock layers between the Todilto Formation and the Dakota Formation in the area around Haystack Mountain. Where these formations outcrop on the surface, one can expect to find the greatest concentrations of uranium minerals. Residences built where these formation outcrop may have higher than normal to very high levels of radon gas.

We recommend that all residences located between the outcrop of the bottom of the Todilto and the top of Dakota be surveyed for radon gas. The areas of greatest concern are in T. 13 N., R. 10 W. and the northeast quarter of T. 13 N., R. 11 W. These areas are indicated on the enclosed maps.

If you have any questions, please contact John Andrews, Chief of the Minerals Staff at 505-761-4504.

Sincerely,

Herrick E. Hanks

Rio Puerco Resource Area

Manager

**Enclosures** 

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	1 (189); (2007-43); 1 (189); (2007-43);		25

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See Figure 1 of SI Report for information on the applicable U.S.G.S. Topographic Quad map.

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Uranium and Thorium Occurrences in New Mexico:
Distribution, Geology, Production, and Resources,
with Selected Bibliography

by

Virginia T. McLemore

New Mexico Bureau of Mines and Mineral Resources

Open-file Report OF-183

September, 1983

NAVAJO SUPERFUND OFFICE
P.O. BOX 2946
WINDOW ROCK, AZ. 86515

Partial Financial Support by U.S. Department of Energy Grand Junction Area Office Subcontract No. 82-555-E

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Mmber	Mine Name	Tona Ore	Pounds U308	\$U3O8	Pounds V ₂ O ₅	1v205	Type of Deposit	Host Rock	Periods of Production/ Shipper
15N.17W.33.21	4 Diamond #2 (Largo #2, Mike Smith Lease)	55,717	244, 939	Ø.22	86,298	doma.	sandstone	Kd	1952-1953 - Adee Dodge Enterprises; 1954-1956- General Uranium; 1955,1956- 1959-Largo Uranium Co.; 1964-1967-A and B Mining
13N.9W.20.411		244,177	906, 235	0.19			sandstone	Jmp	Co.; 1968-1978-Shiprock Ltd 1957-1978 - Four Corners
13N.9W.21.324	Group Iporis-Section 21	31,950	118,052	0.18			sandstone	Jmp	Exploration Co. 1958-1959 - Westvaco; 1959-
, - 14N.18W.11.312	Disart 41	901 000	3 700 407						1960-Phillips Petroleum Co. 1959-1961-Phillips Petroleu Co.; 1959-1961-Phillips Petroleum CoKSN Co.; 1961-KSN Co.
Taria Inn. T. Are	(Section 11)	891,922	3,795,495	Ø. 21	47,438		sandstone	Jmw	1956-1958 - Rio de Oro; 1959 1968-Midcontinent and Rio d Oro; 1961-Rio de Oro; 1961-
_ 14N.10W.11.424	Dymart #2	237,602	894,642	Ø.19	-		sandstone	Jmw	1962-Homestake-Sapin 1959 - Rio de Oro and Mid- continent; 1960-1961-Rio de Oro; 1961-1962-Homestake-
13N.9W.2Ø.233	East Malpais Lease	30, 333	139,818	0.23			sandstone	Jmp	Sapin 1958-1968 - Four Corners
14N.12W.24.243	Elkins Group	59	151	0.13	231	Ø.2Ø	limestone	JŁ	Exploration Co. 1952 - Farris Mines, Inc.;
14N.11W.9.214	¹ Evelyn	10,.743	49,584	ؕ23	23,539	Ø.48	sandstone	Jimb	1953-1954-Josephine Elkins 1953-1956 - Anacorda Co.; 1966-1968-Farris Mines, Inc.; 1969-1976-Smith Development; 1978-Minerals Energy
13N-9H-29-141	Faith-Section 29	66, 327	258,615	Ø.19	-		limestone	Jt '	1958-1959 - Westvaco; 1959- 1968-Phillips Petroleum Co.; 1968-Phillips Petroleum Co.; KSN Co.; 1961-1962-KSN Co.; 1963-United Nuclear; 1963- KSN Co. and United Nuclear;
13N-9W-3Ø-442	Flat Top	49,663	216,486	Ø.22	66,126	Ø.11	limestone	Jt	1964-KSN Co. 1955-1957 - Holly Uranium Co.; 1957-1959-Flat Top Mining Co.; 1963-1966-Baile and Fifa
15N-16W-4-111	Foutz #1	324	1,844	Ø.28	2,676	Ø-41	sandstone	Jinw	1953 - Foutz Mining Co., Foutz Mining Co. and Henosh
15N-16W-5-222	Foutz #2	242	1,045	Ø.22	2,877	Ø.59	sandstone	Jmw	Mines 1953-1954 - Foutz Mining Co.
16N.16W.31.444 14N.11W.8.213	Foutz #3 Francis	2,412 755	8,556 6,164	0.18 0.41	12,466 12,578	Ø.26 Ø.93	sandstone sandstone	Jimb Jimb	1953-1955 - Foutz Mining Co. 1953-1954 - Farris Mines,
	1 _{Haystack}						Manatana		Inc. 1952-1965 - Haystack Mountain
13N-11W-13-314	SW1/4 sec. 13	1,162	2,830	Ø.12	_		limestone	Jt.	Development Corp.
13N.11W.13.444 13N.16W.19.110	Bibo Sec. 19 TOTAL	3,736 137,310 142,208	16,7Ø1 562,267 581,798	Ø.22 Ø.20 Ø.20	165,454 165,494	_			
'3N-9W-14-414	Hogan Mine (Section 14)	129,551	678,510	Ø.26	-		sandstone	Jmp	1959-1961 - Four Corners Exploration Co.; 1962- Homestake-Sapin
15N.18W.12.244	Hogback #3-5	6,354	24,234	<b>8.</b> 19	2,954	Ø.Ø3	shale	Kđ	1951-1953 - Albert Smith; 1954-1956-Hyde Uranium Co.; 1957-1958-Calumet and Hecla; 1958-Mathis and Mathie; 1959-See Tee Mining Co.; 1968-Windsor Mining Co.
:	lisabella (Section 7)	76,748	237,060	Ø·15	-	****	sandstone	Çmp	1959-1961 - Phillips Petroleum Co.; 1961-1962- KSN Mining Co.
4N.11W.35.12Ø SN.14W.12.423		10 60, 109	289,125	0.02 0.24	- 4	Ø. Ø2	sandstone sandstone	Jmb Jmb	1954 - Berryhill and Elkins 1968 - Homestake-Sapin; 1968-1970-United Nuclear- Homestake
≒8-13W-18-442	Mac #2	31,194	189,009	Ø.14			sandstone	Jmb	Homestake 1968 - Homestake-Sapin; 1968- 1976-United Nuclear- Homestake
iN.9₩.2Ø.144	Malpais Raise	42,670	198,492	Ø.24			sandatone	Jmp	1958 - Holly Minerals; 1958- 1961-See Tee Mining Group
3N.9W.23.233	Marquez Mine	723,032	3,757,847	Ø.26			sandstone	ជ្ញា	1958-1964 - Calumet and Heclay 1965-1966-United Nuclear Corp.
.N-16W-11-112	Mary #1 (Dymart #3)	357.262	794, Ø63	0.11			sandstone	Jusa	Nuclear Corp. 1959-1961 - Boyles Brothers; 1962-Boyles Brothers and Entrada Corp.; 1964-Stella Dysart; 1964-Dysart and Homestake-Sapin; 1964-1965- Homestake-Sapin

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Number	Mine Name	Tons Ore	Pounds U ₃ O ₈	<b>\$</b> ∪308	Pounds V ₂ O ₅	1v205	Type of Deposit	Host Rock	Periods of Production/ Shipper
138.9W.2Ø.321	Mesa Top Mine	108,261	512,965	Ø.24	144,610		sandatone	Jmp	1954-1957 - Lea Exploration; 1957-Holly Minerals and Lea
10W.4.244	Pat - Section 4 (Dakota Mine)	5,069	12,645	Ø.12	2,478		sandstone	Jπω, ΚΔ	1952-1959 - Dakota Mining Co.; 1962-1963-Farris Mines, Inc.
13N.9W.19.42Ø	_	217,066	1,004,574	Ø.23	338,694		sandstone	Jub	1952-1959 - Haystack Hountail Development Corp.; 1968- 1962-Farris Mines Inc.
140.11₩.28.113	(T Group)	195	497	<b>6.</b> 13	951	Ø.24	limestone	Jt	1952-1953 - Navajo Develop- ment Co.; 1953-Fitzhugh & Doerrie
13N.10W.16.134 14N.11W.20.144	Red Point Lode Red Top Mines	482 165	1,223 39Ø	Ø.13 Ø.12	746 1,287	Ø.07 Ø.39	limestone limestone	Jt Jt	1952-1955 - R.M. Shaw 1955 - Red Top Uranium
14N.9W.34.424	¹ Sandatone	1,034,255	3,540,829	0.17	-	-	sandstone	Jnu	Mining Co. 1959-1963 - Phillips Petroleum Co.; 1963-1978-
13N.9W.1.200	1Section i (13N-9W) mined through Cliff	148,966	1,699,137	0.57		-	sandstone	Jnw	United Nuclear Corp. 1967 - Kerr-McGee; 1969-1970
15w.16w.3.332	Section 3 (15N-16W) Santa Fe-Christense Rats Nest Mine	324	1,836	Ø.28	404		sandstone (coal)	Kd	Kerr-McGee and Nation Lead 1957 - Christensen and Rem Uranium Co.; 1957-1958-Rem Uranium Co.
13N.10W.5.144 13N.9W.8.114	Section 5 (13N-10W) Section 8 (13N-9W) Spencer Shaft	47,808	54 165,319	Ø.12 Ø.17			sandstone sandstone	Jub kq	1958 - Westvaco 1958-1962 - United Western; 1961-Hyde and Camper; 1964- 1966-W.D. Tripp; 1966-1967-
14N.10W.10.244	¹ Section 10 (14N-10W)	130,767	510,935	Ø.2Ø	_	_	sandatone	Jaw	James J. Goode 1957-1962 - Kermac Nuclear;
14N.10W.12.411	¹ Section 12 (14N-10W)	74,975	211,873	Ø.14	-		sandstone	Jinw	1964-Homestake-Sapin 1961 - Anderson Development Corp.: 1962-1963-Stella
14N.10W.15.441	(14N-1ØW)	1,213,814	3,625,924	Ø.15		-	sandstone	Jase	Dyeart 1958-1961 - Homestake-Sapin; 1961-1965-Rio and Home- stake-Sapin; 1966-1969- Homestake-Sapin; 1969-1978-
14N.9W.17.323	¹ Section 17 (14N-9W)	544,164	2,315,182	Ø.21			sandatone	Jmw	United Nuclear-Homestake 1960-1964 - Kermac Nuclear Corp.; 1965-1970-Kerr-McGee
	-Section 18 (13N-10W) (Indian Allotment)	<b> 25,</b> 796	98,175 ~	~ Ø.19 -	75,342	Ø.3Ø	limestone	Jt	1952 - Sutton, Thompson, Williams; 1953-Williams; 1955-Santa Fe Uranium; 1955- 1956-Santa Fe Uranium and Federal Uranium; 1957-1959- Federal Uranium; 1963-1964- Mesa Mining Co.; 1966-Cibol Mining Co.
	Section 18 (14N-9W) mined through Sec.		1,586,447	Ø.16			sandstone	Janu .	1962-1964 - Kermac Nuclear; 1965-1970-Kerr-McGee
4N.10W.22.223	Section 20 (14N.9W) mined through Sec.		2,223,977	Ø.23		<del>-</del> ;	sandstone	Jnw	1962 - Kerr-McGee
IAN.10W.23.134	(14N-10W) hearn learn	2,189,051 h — 2,528,797	11,605,672 38,105	Ø.18 —	=	_	sandstone	Jaw	1958-1964 - Kermad Nuclear; 1965-1970-Kern-McGee
	(14N-10W) Section 23 (13N-10W)		9,679,773	Ø.19			sandstone	Jime	1959-1968 - Homestake-Sapin; 1969-1970-Homestake-United Nuclear
3N.9W.24.121	Section 24 (13N-9W)	21,826 1ø,95ø	138,541 37,693	Ø.32	10,256	8.86	limestone	Jt.	1957-1965 - Hayetack Hountain Development Corp.; 1965- 1966-Santa Fe Pacific 1968-1963 - Feboo Mines, Inc
	Chill Wills, Rialto (Section 13) -Section 24 (13N-11W).	-	·		85,545			Jmp	1952-1954 - Glen Williams:
	Indian Allotment to Nana-A-Bah Vandever	•	115,075~	w.22 °	63,343	Ø.18	limestone	Jŧ	1952-1956 - Glen Williams 1955-1956-Santa Fe Uranium; 1955-Federal Uranium Corp. Santa Fe Uranium; 1956-1957- Federal Uranium Corp.
.4N.10W.24.332	Section 24 1 (14N-10W) Heap leach	.,984,582	7,Ø71,564 579	Ø.19 —			sandstone	Jmw	1959-1964 - Kerr-McGee Nuclear; 1965-1970-Kerr- McGee
	Section 25 (13N-10W)	235,156	958,058	Ø.2Ø	153,657	0.12	limestone	Jt	1952 - A T and SF RR; 1955- 1961-Haystack Mountain De- velopment Coxp.; 1962-1963- Santa Fe Pacific; 1963- Farris Mines, Inc.; 1963- 1965-Santa Fe Pacific; 1965- 1966-Farris Mines, Inc.; 1968-Hymestake; 1969-1978- United Nuclear Coxp.
4N.10W.25.144	(14N-10W)	1,791,048	6,444,889	Ø.18			sandstone	Jaw	1959-1969 - Homestake-Sapin; 1969-1970-Homestake-United Nuclear
	Section 26 (13N-10W)- Desidero Group		—> 83,752 —	- Ø.38 -	17,518	- 8.08 -	limestone -	_ Jt	- 1952-1957 - Hanosh Mines
14N.10W.26.220	Section 26 (14N-18W) mined through Section 24	362,110	1,198,696	Ø.17	-	-	sandatone ,	Jmu	1965-1970 - Kerr-HcGee

1: 13N.11W.13.314 2: Haystack-Section 13 Pit (NM-B-1 lease, Bilba, Arthur Bibo, Railroad Sec.) NW1/4 SW1/4 13 T13N R11W 35°21'15"N 107°57'32"W 3: Bluewater 7-1/2 Elevation 7,050 ft 4: 5: Ambrosia Lake subdistrict-Grants uranium district 6: U, V, limestone 7: two coalescing open pits - 60-ft deep 1,162 tons ore yielding 2,830 lbs U308 (0.12%) until 1970 8: Jurassic Todilto Limestone 1Ø: mineralization in upper limestone, associated with 11: intraformational folds 13: Limestone 14: produced 1958, 1961 by Arthur Bibo; then 1976-1981 by Todilto Exp. and Dev. Co. (production included in Haystack-Section 13, 13N.11W.13.324 FN 5/21/82; Green and others (1980c, #183); Siemers and Austin (1979); Hilpert (1969, p. 37, #17); Kittle and others (1967); McLaughlin (1963); U.S. Atomic Energy Commission (1959a, p. 52); Fincher and Konigsmark (1957); Anderson, E.C. (1955); PRR CEB-16 (1950); USAEC files (1965); USDOE files (1982) 1: 13N.11W.13.324 2: Haystack-Section 13 (NM-B-1 lease) SW1/4 13 T13N R11W 35°21'20"N 107°57'20"W 3: Bluewater 7-1/2 Elevation 7,100 ft 4: 5: Ambrosia Lake subdistrict-Grants uranium district 6: 7: 1,700-ft decline, open pit 191,000 tons of ore yielding 458,579 pounds of U308 at an 8: average grade of  $\emptyset.112%$   $U_3O_8$  (USDOE files) 1Ø: Jurassic Todilto Limestone, Entrada Sandstone 11: 3-ft thick, six ore bodies found in this area 13: Limestone 14: produced 1975-1981 by Todilto Exp. and Dev. Co.; includes all production from NM-B-1 Lease FN 5/21/82; Green and others (1980c, #313, 316, 328); USAEC 15: files (1965); USDOE files (1982) 16: figure 14 1: 13N.11W.13.444 Haystack-Section 13 (NM-B-1 lease, Railroad section, Arthur Bibo) 2: SE1/4 13 T13N R11W 35°21'15"N 107°57'00"W 3: Bluewater 7-1/2 Elevation 7,101 ft 4: 5: Ambrosia Lake subdistrict-Grants uranium district 6: 7: open pit - extension of Haystack Section 19 3,736 tons ore yielding 16,701 lbs  $U_{3}O_{8}$  (0.22%  $U_{3}O_{8}$ ) 8: 1Ø: Jurassic Todilto Limestone Limestone 13: Green and others (1980c, #184, 314); Hilpert (1969, p. 37); 15: PRR CEB-16 (1950); USAEC files (1965) 1-235

1: 13N.11W.24.222 **→**2: Section 24 (Indian Allotment, Nan-A-Bah, Glen and Edith) 3: NE1/4 24 T13N R11W 4: Bluewater 7-1/2 Elevation 7,110 ft 5: Ambrosia Lake subdistrict-Grants uranium district 6: 7: open pit (15-20 ft deep) 24.638 tons ore yielding 115,075 lbs U308 (0.22%); 85,545 8: lbs V205 Jurasšič Todilto Limestone 1Ø: several orebodies, largest was 640-ft long and 100-145 ft 11: wide, related to northwest trending folds 13: Limestone 14: mined 1952-1957 15: Green and others (1980c, #185); Anderson, O.J. (1980); Holmquist (1970, p. 106); Hilpert (1969); McLaughlin (1963); Anderson, E.C. (1955); USAEC files (1957) 14N.1ØW.24.332 1: Section 24 (Section 24 and 26) 2: SW1/4 24, NE1/4 25 T14N R1ØW 35°25'21"N 107°51'9"W 3: Ambrosia Lake 7-1/2 Elevation 7,010 ft 4: Ambrosia Lake subdistrict-Grants uranium district 5: 6: U. Mo 848-ft vertical shaft 7: 8: 1,904,582 tons ore yielding 7,071,564 lbs U308 (0.19%) plus 579 lbs U308 by heap leach unti 11970 Jurassic Morrison Formation-Westwater Canyon Member 10: 4 horizons, 8-67 ft thick 11: 13: Sandstone - primary tabular mined 1959-1980 by Kerr-McGee; some ore locally in lower 14: Brushy Basin Member; on standby status in 1982 15: FN4/5/82; Green and others (1980c, #140); Chapman, Wood, and Griswold, Inc. (1979, #30); Siemers and Austin (1979); Holmquist (1970, p. 66); Hilpert (1969, p. 40, 69, #84); Santos and Thaden (1966); U.S. Atomic Energy Commission (1959a, p. 56); USAEC files (1971); NMBMMR files (1964); CRIB (1981)

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MANGALO SUPERFUIND PROCRAMINATION CONTRACTION CONTRACTIONS AND AND CHARCHEST CONTRACTIONS AND CHARCHES

## AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY PUBLIC HEALTH ADVISORY

NAVAJO-BROWN VANDEVER
AND
NAVAJO-DESIDERIO URANIUM MINING AREAS
NAVAJO NATION
BLUEWATER, NEW MEXICO

November 21, 1990

#### Statement of Purpose

This Public Health Advisory is issued to inform the Environmental Protection Agency (EPA), the Navajo Nation, the Indian Health Service (IHS), the Bureau of Indian Affairs (BIA), the State of New Mexico, and the public of a potential significant environmental hazard to human health rear Bluewater, New Mexico. After evaluating available information (1,2) and visiting the area, the Agency for Toxic Substances and Disease Registry (ATSDR) has determined that this Public Health Advisory is warranted for the Navajo-Brown Vandever (N-BV) and Navajo-Desiderio (N-D) Uranium Mining Areas. The presence of uranium-containing radioactive mine wastes, areas potentially contaminated with heavy metals, and many physical hazards form the basis of this Advisory. Because of these potential hazards to human health, the ATSDR is recommending that these sites be evaluated for inclusion on the National Priorities List.

At the request of the EPA, Region VI, and the Navajo Superfund Office (NSO), the ATSDR initiated preliminary investigations of the radiological, chemical, and physical hazards associated with the N-BV and N-D uranium mines. These sites are not currently on the National Priorities List, but the NSO and the EPA are currently developing Preliminary Site Assessments.

Two site visits by the ATSDR staff were made to the Mavajo-Brown Vandever and Navajo-Desideria Uranium Mining Areas. Field monitoring data were taken at the time of the visits. The ATSDR has concluded, based on the site visits, the data acquired during the visits, and the evaluation of other available information, that radioactive materials potentially hazardous to human health may be present at these sites. These hazardous materials include uranium-containing mine wastes with radiation levels potentially hazardous to human health, areas potentially contaminated with heavy metals at soil concentrations potentially hazardous to human health, and many physical hazards of public health concern. This finding has led to the issuance of this Public Health Advisory.

#### Background

The N-BV and N-D sites are in Bluewater, about 4 and 9 miles east of Prewitt, New Mexico, respectively (1,2). Both areas are in the Ambrosia Lake subdistrict of the Grants Uranium Mining District. Access to the areas is over improved dirt roads. These mining areas are in agricultural rural settings and adjacent to residential properties. Both mines are located on land owned by the Navajo Nation and held in trust by the Bureau of Indian Affairs, United States Department of Interior. The current owner of the N-BV mine is Mr. Brown Vandever, who lives at the site with his extended family. The owner of the N-D mine is Mrs. Jenny Desiderio, who inherited the mine from her deceased husband and lives on the site with her extended family.

The NSO estimates that at each site there are approximately 65 people, 30 of whom are children. Less than 3 miles from the sites is a preschool with a student enrollment of about 30 children. The NSO also estimates that about 500 persons are potentially impacted by environmental hazards at these sites.

A potable municipal-type water supply system for the area is derived from a well installed by the IHS. The NSO estimates depth of the well is about 1,100 feet. However, the NSO believes that not all residents are on this water system. The wells used by those residences not on the public supply are well systems operated by windmills.

The N-BV area encompasses about 155 acres (1), and the N-D mine covers about 130 acres (2). Within a mile of the N-BV mine is the Navajo-Nanabah Vandever (N-NV) mine site. These sites initially were open-pit mining operations. Besides the open-pit operations, the N-BV area operated as a subsurface mine. The site therefore includes horizontal mine shafts and ventilation shafts, some of which are almost vertical. During the site visits, the ATSDR observed that household wastes had been deposited into some of these shafts. It was apparent that local residents were still using these shafts for solid waste disposal.

Historically, the N-BV mine was operated periodically from 1952 to 1966 by various companies including Santa Fe Uranium, Federal Uranium Mesa Mining Company, and the Cibola Mining Company. During the operations of this mine, conventional mining techniques were used. The ore removed from the mine was believed to be sorted by hand and shipped to regional mills located near Ambrosia Lake or Shiprock, New Mexico, or the Durango, Colorado, areas. In its draft Preliminary Assessment of the site, the NSO documented that over 25,000 tons were removed from the mine. The ore processing produced about 49 tons of uranium oxide (U₂O₂) and over 37 tons of vanadium pentoxide (V₂O₂). Ores not meeting the screening criteria for uranium content were discarded at the mine site. These ores now line the roads leading to the Brown-Vandever residential and mine areas (1).

From 1952 to 1957, the N-D mine was operated by "Sante Fe" (exact name unknown, may not be the same company as previously mentioned) and the Hanosh Mines from Grants, New Mexico. The mining technique involved removing the soil overburden with heavy equipment followed by drilling and blasting the ores loose. The ores then were trucked to area mills for processing. Ores not meeting the minimum requirements for uranium content were disposed of at on-site locations. The NSO estimates that the 11,110 tons of ore removed by this operation contained over 83,000 pounds of  $\rm U_2O_8$  and over 17,500 pounds of  $\rm V_2O_8$  (2).

At both the N-BV and the N-D mines, the physical hazards are of particular concern to the ATSDR because of the number of children known to reside in the areas. The physical hazards observed by ATSDR include both open mine shafts and open pits. Because of the depth of the shafts and the unrestricted access, an inadvertent intruder either entering or falling into the shafts could be difficult to find and rescue.

#### Explanation of Terms

This document uses terms associated with radioactivity and dose resulting from radiation exposure. These terms are defined here.

<u>curie</u> -- A curie (abbreviated Ci) is the unit used to measure the amount of radioactivity. It is equal to the amount of radioactivity in 1 gram of radium (1 gram = 1/28 ounce or 0.0022046 lb). A picocurie (pCi) is one trillionth of a curie (1 x  $10^{-12}$ ). One trillionth is the same as 1 second in 320 centuries or 1 inch in 16 million miles. Exposure levels of the radioactive gas radon are commonly expressed as picocuries per liter of gas (pCi/L).

<u>roentgen</u> -- A roentgen (abbreviated R) is used to measure exposure to ionizing radiation, such as gamma rays or X-rays. Gamma radiation is energy given off by certain radioactive substances, such as uranium and radium. Basically, a roentgen defines the amount of energy given off by these radioactive substances into the air. An exposure of 1 R = 87.7 rads per 1 gram of air.

<u>rad</u> -- The abbreviation "rad" stands for <u>radiation absorbed dose</u>. It measures how much radiation is absorbed by a material after exposure to radiation. It is equal to 100 ergs of energy per gram of material (an erg measures energy).

rem -- The abbreviation "rem" stands for goentgen equivalent man. It is a function of the radiation absorbed dose (rad) and the type (or quality) of radiation. In terms of radiation quality, gamma rays are the least harmful internally to humans and alpha particles are the most harmful. The effect of 1 rem is approximately the same as that of 1 R of X-ray or gamma ray radiation. A millirem = 1/1-thousandth of a rem, the same as a dollar in \$1,000. A microrem = 1/1-millionth of a rem, the same as 1 minute in 2 years or 1 inch in 16 miles. Throughout the United States, the average natural radiation exposure (called "background levels") is nearly 300 millirems per year. This includes exposure to radon.

Background radiation occurs from natural sources in the earth's crust. Several naturally occurring radioactive materials contribute to this source of radiation. These include, but are not limited to, uranium, thorium, rubidium, and a small percentage of potassium. Other sources contributing to the background include fallout from cosmic radiation, materials made radioactive as a result of interactions with the cosmic radiation, and nuclear weapons testing. A measurement of the background radiation was collected at Prewitt, New Mexico, approximately 3 miles from these sites by the ATSDR and the NSO. Using radiation detectors sensitive to gamma radiation, the background radiation at Prewitt was estimated to be 6 microroentgens per hour (uR/h). This is equivalent to an annual exposure of 53 millirem, not including radon.

#### Basis for Advisory

During the week of July 24-27, 1990, and November 1, 1990, personnel from ATSDR Headquarters and Regions VI and IX offices toured these sites. Accompanying the ATSDR personnel were representatives of the local Navajo chapter and the NSO. During the visits, radiation readings were collected by both the ATSDR and the NSO. Discussions also were held with officials and members of the Navajo Nation concerning life-styles, populations, health concerns, and land use in these areas.

#### A. Navajo-Brown Vandever (N-BV) Site

Along the roadbed leading to the Navajo-Brown Vandever site, the area was littered with rocks and ore tailings. Mine tailings from the nearby Nanabah Vandever mine were within 100 feet from the roadbed. These piles were partially overgrown with vegetation. Within the materials along the roadbed, the uranium ores (yellowish material) were clearly visible. Environmental radiation readings along the road, obtained with a calibrated Ludlum Model 19 gamma radiation detector equipped with an NaI(Tl) scintillator, ranged from approximately 50 microroentgens per hour (uR/h) to over 500 uR/h, whereas the naturally occurring background radiation reading was 6 uR/h. The background radiation measurements were obtained in Prewitt, New Mexico, approximately 3 miles from the sites. Radiation monitoring evidence also suggested that radioactive material had migrated off-site because of both wind-borne distribution and surface runoff during seasonal rains. Additional radiation monitoring indicated that some residential structures contained radioactive material in the foundations and that radioactive materials were also present within 20 feet of the residential areas.

At the main mine shaft located in the pit-mined area, ore tailings were randomly piled around the site and radiation readings were elevated above background. A horizontal shaft entering the mountain was observed; and during discussions with local residents, it was mentioned that the shaft branches into three sections. Entrance to this mine shaft is not restricted. Vertical ventilation shafts were also observed; one shaft was about 10 degrees from vertical. A small shack was constructed over this

ventilation shaft, however, access to the shaft was not effectively restricted. Located near the residential areas were open adits (shafts) being used as solid waste disposal areas by the local residents. These adits may run at least 300 feet in length or depth. The residential areas are less than 200 feet from several adits, and access to these adits is also unrestricted.

Although air sampling data are lacking, because of the uranium content of these mines, the shafts provide an excellent path for the release of radon, a naturally occurring by-product of uranium decay. It is reasonable to infer that the release of radon from these mines could elevate ambient radon to levels potentially hazardous to human health at this site.

During mining operations, analysis of the ores indicated the presence of heavy metals. These included vanadium, arsenic, barium, chromium, magnesium, manganese, strontium, titanium, and zirconium. Leaching may have occurred from these ores; however, no analyses of environmental samples are available to verify the presence of these contaminants. Although recent sampling information is lacking, the potential exists for humans to be exposed to these contaminants through ingestion or inhalation.

#### B. Navajo-Desiderio (N-D) Site

The Navajo-Desiderio mine is a series of open-pit areas of approximately 30 to 50 feet in depth and of varying lengths. The radiation readings at this site were about 50 uR/h. No restricted access to the pits was observed during the site visit; children play and livestock graze freely in the area, and residential areas are within 100 yards of the pits.

Through a Navajo interpreter, the owner of the mine, Mrs. Jenny Desiderio, informed us that her grandson fell into one of the pits during a sledding accident. The child, who reportedly suffered brain damage, died a few years after the accident. According to Mrs. Desiderio, at least 18 livestock died after ingesting contaminated rainwater that reportedly collects in the pits. Whether the dead animals were examined by a veterinarian is not known. Although sampling data are lacking, the MSO officials believe the animals may have died after ingesting heavy metals which may have leached from the ores into the pit areas.

#### C. Discussion of Site-related Radiological Contaminants

Of the verified contaminants in these areas, those of concern are uranium and a member of its decay series, radon. Of the naturally occurring isotopes of uranium, uranium-238 (U-238) is the most abundant, present at concentrations greater than 99 percent. The primary mode of decay is via two alpha particles, each with a decay energy of approximately 4.2 million electron volts (MeV). The decay chain of which U-238 is the parent results in the production of both radium-226 and radon-222 and ultimately

terminates with stable lead-206. During this decay series, beta particles and gamma rays are produced as well as additional alpha particles, all at different decay energies (3). Because uranium is ubiquitous in nature, the daily human dietary intake is approximately 1.9 micrograms (4). Therefore, the body normally contains an estimated 90 micrograms of uranium. This corresponds to a body burden of about 30 picocuries. Of this amount, about 66 percent is associated with the skeleton; the remainder is in the soft tissues. The biological half-life is 100 days for whole body and 15 days for the kidneys (4).

After ingestion, the fractional uptake of uranium into the blood is 0.05 for water-soluble inorganic forms and 0.002 for water-insoluble forms (5). The critical organs for ingestion are the skeleton and kidneys. The lung surfaces are the critical organ after inhalation, although there is some solubilization of deposited uranium followed by absorption or ingestion (4).

Because Rn-222 is an inert gas, most of the inhaled gas is exhaled, with only that which decayed potentially remaining within the lungs. These radioactive materials deposited within the lung expose the bronchial epithelium lining the respiratory system, resulting in an elevated risk of lung cancer (5,6). Exposure to radon and radon progeny has been directly correlated with the appearance of lung cancer in humans. The first epidemiological studies of radon exposure were conducted in 1879, in Europe. Since then, such studies have been conducted worldwide and many are still in progress. The studies involve uranium miners and show increasing risks of lung carcinomas as accumulated exposure to these products increased (6).

Rn-222 decays by emitting an alpha particle with an energy of approximately 5.5 MeV and gamma rays with an energy of 0.51 MeV. The half-life of Rn-222 is 3.8 days (3). The decay products are also radioactive, emitting mostly beta particles and gamma rays with an alpha particle released during one decay step. These radon progeny, with half-lives ranging from seconds to over 20 years, ultimately decay to a stable (nonradioactive) form of lead.

The effects of biological exposure to radon are difficult to evaluate. Radon is inert and therefore does not attach to surfaces. However, the decay progeny are charged particles and can electrostatically attach to surfaces. Most progeny immediately attach to aerosols. The ratio of attached progeny to unattached progeny is important in dose calculations for as the ratio increases, the radiation dose to lung surfaces increases. Other factors affecting the lung dose include the ratio of Rn-222 to its progeny, the breathing patterns, lung characteristics, sex, and age of the individual exposed. In a recent report from the National Research Council (NRC), the dose from the radon progeny was of greater risk than exposure to radon gas (6). Dose estimates have been published by the National Council on Radiation Protection and Measurements (NCRP) (5). The NCRP estimates that the risk of developing lung cancer

following a lifetime exposure to Rn-222 is  $2.1 \times 10^{-3}$  per pCi/L exposure under environmental conditions. The NCRP also states that the dose to the bronchial regions of a typical working adult because of exposure to Rn-222 is 0.27 rad per year per pCi/L. For a 10-year old child (12 hours active, 12 hours resting), the dose estimate is 0.45 rad/year per pCi/L.

#### D. Estimates of Radiation Exposure to Local Residents

Because detailed environmental monitoring for heavy metals and radioactive materials has not been supplied to the ATSDR, it is difficult to determine the health risks due to internal uptake of these materials. However, the external exposure to ionizing radiation can be evaluated using the on-scene monitoring results obtained by the ATSDR and the NSO. It is possible that the radiation exposures at these sites poses an imminent radiation health hazard to local residents. For the sites discussed in this Health Advisory, the ATSDR is defining an imminent radiation health hazard as exposures that exceed the regulations for radiation exposure to minors (as described in 10 CFR 20.104) and exposure to the public in areas of unrestricted access (10 CFR 20.105).

The Brown-Vandever mine site is in a residential area. In estimating the annual exposure to external ionizing radiation because of the contaminants in the area, the ATSDR used the following assumptions for a maximally exposed individual (MEI). The MEI would live on the site for 100 percent of the time (24 hours) and 365 days per year. The average exposure, including background in the area, is estimated conservatively to be approximately 125 uR/h. Assuming these values and the 24-hour exposure, the external radiation at this site could result in an individual receiving an external annual exposure of nearly 1 R, about 5 percent of which is from natural background as measured in the vicinity of the site (6 uR/h for 8,760 hours).

The risks of exposure to radiation have been investigated for nearly 100 years and the values have been extensively peer reviewed and accepted by the scientific community. In terms of risk estimates, the WCRP, in 1987, used a risk value for excess cancer mortality of 1 x 10 per rem per year for whole body exposure (7). In 1990, the NRC released the Biological Effects of Ionizing Radiation Report V, (BEIR V) (8). This report places the risk of excess cancer mortality as a result of continuous lifetime exposure to 0.1 rem pe- year at 520 for males and 600 for females per 100,000 population (Table 4-2, BEIR V report). Using the estimated population of 500 persons for this area, this would calculate to approximately three excess cancer deaths to residents as a result of exposure to the radiation over an estimated lifetime of 70 years. The American Cancer Society estimates that the expected rate of cancer deaths is on the order of 15 to 25 deaths for a population of 500 individuals.

Furthermore, because of the inherent production of radon released from the uranium-containing ores, the internal radiation dose, especially to the bronchial epithelium of the lungs, could be even higher. In a 1988 report, the NRC stated that the estimated dose to these tissues far exceeds any dose to organs from external natural background radiation (6). As an organ system, the allowable exposure limits for the lungs can exceed the whole body exposure dose limits (7). However, since no specific radon measurements have been made in this area, estimates of potential internal lung exposure to radon cannot be evaluated at this time.

#### Conclusions

The Agency for Toxic Substances and Disease Registry concludes that the Navajo-Brown Vandever and the Navajo-Desiderio Uranium Mining Areas may pose a potential significant hazard to human health for residents of these areas based on these premises:

- 1. The predictions of the external exposure model using the estimated exposures to ionizing radiation exceed the recommendations of the National Council on Radiation Protection and Measurements by a factor of 10. These recommendations state that the public exposure limit to continuous or frequent ionizing radiation should not exceed 0.1 rem per year (7), whereas, the estimated exposure to residents in the vicinity of the Brown Vandever mine could be on the order of 1 R (equivalent to 1 rem).
- 2. Possible human consumption of livestock potentially contaminated with heavy metals following the ingestion of standing water may pose a hazard to human health.
- 3. The many open mine areas, mine shafts, and the unrestricted access to these areas create a safety hazard.
- 4. Since evidence suggests that radioactive contaminants are migrating off-site and that heavy metals may be associated with the radioactive material, local food and livestock crops could be contaminated. This could result in a significant internal exposure to both radioactive materials and heavy metals if these crops are ingested.
- 5. It is apparent that not all local residents are supplied with public water. Because of the runoff and surface contamination around these sites, the water quality of the individual wells may be suspect and hazardous to humans chronically exposed to radioactive materials and heavy metals.

### RECOMMENDATIONS The ATSDR proposes the following health actions to assist local residents: 1. The ATSDR, in coordination with the Navajo Tribal Council, the IHS, the BIA, the State of New Mexico, and other appropriate agencies, will conduct an environmental health education program to advise the public and medical community of the nature and possible consequences of exposure to ionizing radiation and heavy metal contaminants at the N-BV and N-D sites. Health education materials and assistance will be provided to local health care providers and other appropriate local public health officials. The ATSDR will consider conducting health surveillance activities for populations at these sites. 3. The ATSDR will consider conducting a radiation or heavy metal exposure study of the local residents once additional health-related information on the local residents becomes available. Because of the limited environmental sampling data available to both the ATSDR and the EPA, we recommend the following additional actions to protect the public health of area residents: The responsible environmental regulatory agencies should within the calendar quarter, initiate data collection efforts to begin the characterization and determination of the extent of the radioactive contamination and possible presence of heavy metals. This sampling should include public water supplies and private wells in the area. Those wells exceeding standards should not be used for potable water and residents should be supplied with alternate potable water. 5. During this phase, personal radiation dosimeters and radon detection devices should be provided by the appropriate agencies to local residents to begin to estimate the external radiation exposure being received. During these environmental studies and personal monitoring efforts, if the data being collected indicates that an imminent radiation health hazard exists to the area residents, then immediate steps, including consultation with the ATSDR, should be taken to mitigate that health hazard. 7. The mitigation or remediation would include, as appropriate, dissociation of local residents from the site until the direct public health hazard is removed. The remediation of the public health hazard should occur in the most expeditious manner consistent with Federal and State environmental protection, health, and radiation protection laws and regulations. Appropriate steps should be taken to protect public health during any removal actions (e.g., dust control, site access restrictions, and monitoring of radiation levels).

8. If these analyses indicate that the radiation exposures would result in a long term, chronic exposure, then applicable measures should be taken by the appropriate remedial regulatory agencies to remediate the public health hazard in the most expeditious manner and consistent with all applicable Federal, Tribal, and State quidelines and recommendations. The appropriate agency should sample biota, food crops, and livestock to ascertain the potential for internal radiation exposure through consumption of contaminated food products and to identify addition potential sources of external exposure. 10. The appropriate responsible agency should take steps to prevent access to or otherwise make physically safe the various open mine areas, pits, and shafts. 11. Governmental agencies and any involved private sector organizations should work closely with Navajo representatives to ensure that cultural awareness and respect are observed and practiced.

For additional information, please contact the ATSDR at the following address:

Robert C. Williams, P.E.

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(404) 639-0610
FTS 236-0610

#### REFERENCES.

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- 6. National Research Council. Health Risks of Radon and Other Internally Deposited Alpha-emitters. BEIR IV. Washington, D.C.: National Academy Press, 1988.
- 7. NCRP. Recommendations on Limits for Exposure to Ionizing Radiation. NCRP Report 91. Bethesda: National Council on Radiation Protection and Measurements, 1987.
- 8. National Research Council. Health Effects of Exposure to Low Levels of Ionizing Radiation. BEIR V. Washington, D.C.: National Academy Press, 1990.

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#### Department of Energy

Grand Junction Projects Office
Post Office Box 2567
Grand Junction, Colorado 81502-2567

June 21, 1991

Mr. Robert E. Bornstein, On-Scene-Coordinator Emergency Response Section U.S. Environmental Protection Agency Region IX 75 Hawthorne Street San Francisco, CA 94105

Dear Mr. Bornstein:

I have reviewed the draft "Action Memorandum" dated May 17, 1991; the data transmitted by your letter dated May 10, 1991; and, the January 24, 1991 letter from the Navajo Nation. Based on my review of the data, an on-site inspection of the Department of Energy (DOE) lease tract and discussions with personnel specializing in the areas of mining, environment, health and safety, the following comments are proffered.

As a brief overview of the involvement of the DOE, the land identified as the south east quarter (SE 1/4) and the south half of the north half (S 1/2 N 1/2) of Section 13, Township 13 North, Range 11 West, New Mexico Principal Meridian located in McKinley County, New Mexico, was withdrawn from the public domain under Public Land Order 964 for the use of the Atomic Energy Commission which was a predecessor agency to the DOE. On October 1, 1973, "Invitation for Bid" 60.8-R-S-2 was issued on a competitive basis for the purposes of development and operation of a uranium mine on the subject property. As a result of the solicitation, lease number AT(05-1)-ML-60.8-NM-B-1 was issued to George Warnock (an individual). Subsequently, Mr. Warnock incorporated the lease under the name of TODILTO Exploration and Development Corporation. The lease was operated during the period of June 1974 through December 1981. Upon cessation of the mining activities, partial reclamation activities were completed on the lease tract as evidenced by the November 19, 1987 Department of Interior letter previously provided to you.

The primary concern I have with the draft "Action Memorandum" is that the concerns associated with the DOE lease tract are not specifically addressed but rather are grouped together with the adjoining property referred to as the Brown-Vanderer mine. Having performed an on-site inspection of the DOE lease tract, I am of the opinion that the DOE has shown very good stewardship of its lease. One minor safety issue was noted and corrective action has been taken to permanently install a barrier to prevent unauthorized or accidental entry into the ventilation shaft located on the eastern portion of the DOE lease tract until such time as the proposed corrective actions set forth below are taken. The only environmental issues noted were the release of radon gas through the various portals and the slightly elevated gamma readings in the area of the former ore stockpile station and mining rubble areas. Therefore, it is important to segregate the issues associated with the DOE lease tract from the surrounding mining activities.

June 21, 1991

In order to mitigate the concerns associated with the DOE lease tract, I amproposing that the following actions, illustrated in the enclosed drawings, be taken:

- 1. All inclines and/or declines will be excavated to a depth of four feet and will be plugged with a removable, oversized concrete plug approximately six inches thick and then backfilled and mounded with native material. (See Drawing 1)
- 2. In the event that the existing timber sets in the raised ventilation/emergency escape structure will not permit the corrective action presented above, then an eight inch reinforced slab will be poured to block the portal and mounded with native material. (See Drawing 2)
- 3. The area of the former ore stockpile station will be scraped approximately one foot in depth. The material removed from the former ore stockpile station will then be placed in the main portal; a concrete (CMU) wall will be installed and material from the area immediately adjacent to the main portal will be graded against the main portal area. (See Drawing 3)
- Should any areas remain with gamma readings above the 300 uR/h level, those areas will be posted with tri-lingual signs advising of a potential radiological risk.

It is the opinion of the DOE that the proposed actions described above and illustrated on the enclosed drawings, will adequately mitigate the health risks identified by the Agency for Toxic Substance and Disease Registry and will not preclude the reopening of the mine in the future should the need arise. In addition, the proposed corrective action would also serve as a permanent reclamation (with the possible exception of applying an earth overlay in the area of the main portal to act as shielding material) should the existing lease be terminated in the future.

The proposed timeframe for corrective action would be July - August 1991. However, before any action is taken by the DOE, I would appreciate written concurrence from you for the proposed action. As I have discussed with you in the past, the DOE is aware of its environmental, health and safety responsibilities and is prepared to respond in the appropriate manner when issues are discovered.

It is my understanding that based upon approval from the Environmental Protection Agency (EPA) of DOE's proposed corrective action, the EPA will agree not to include the DOE lease tract within the scope of the emergency

Mr. Robert E. Bornstein June 21, 1991 response action proposed by the EPA for the adjacent areas, which are not within DOE's custody or control. The performance of corrective action by the DOE in the DOE lease tract should not be deemed to be a waiver of any defense or right DOE may have. Thank you again for your cooperation, and if you have any questions, please call me at 303/248-6003. Robert E. Ivey Contracting Officer cc: J. Lyle, DOE/ID R. Churan, DOI M. Olsen, DOE/ID
V. Tonc, Geotech

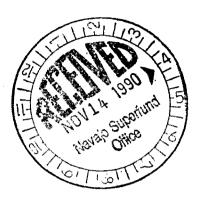
NAVAJO SUPERFUND PROGRAM

Nanobah Vandever SI Report



### UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION IX

75 Hawthorne Street San Francisco, Ca. 94105



NAVAJO-BROWN VANDERVER
AND
NAVAJO-DESIDERIO URANIUM MINING AREAS
NAVAJO NATIONS
BLUEWATER, NEW MEXICO
PRELIMINARY ASSESSMENT WORKPLAN

Prepared by Robert Bornstein
United States Environmental Protection Agency
Emergency Response Section
November 9, 1990

#### I. INTRODUCTION

On October 3, 1990, the Emergency Response Section (ERS) was notified by the Agency for Toxic Substances and Disease Registry (ATSDR) of the potential health hazards associated with the uranium mining tailing located at the Navajo-Brown Vanderver (N-BV) and Navajo-Desiderio (N-DO) Uranium Mining Areas. At this time, the ATSDR is drafting a Public Health Advisory for these areas based on the potential adverse environmental and health hazards associated with these mining sites.

#### II. BACKGROUND

The N-BV and N-D sites are located in Bluewater, New Mexico. The sites are located on land administered by the Navajo Nation and lie within the Ambrosia Lake subdistrict of the Grants Uranium Mining District. The N-BV mine encompasses approximately 155 acres, and the N-D mine covers about 130 acres. The Sites lie within a sparsely populated agricultural area. The Navajo Nation estimate that approximately 500 people may be affected by the environmental hazards associated with these sites.

The N-BV mine was operated periodically from 1952-1966 and was operated by several mining firms including Santa Fe Uranium, Federal Uranium Mesa Mining Company, and the Cibola Mining COmpany. The operations consisted of both surface and subsurface mining techniques. Several open shafts and large pits are visible at the site and access is not restricted. The mined ore was hand sorted and shipped to various milling operations located in Shiprock, New Mexico, or the Durango, Colorado, area. It is estimated by the Navajo Nation that approximately 25,000 tons were removed from the mine. The ore was processed into approximately 49 tons of uranium oxide  $(U_3O_8)$  and over 37 tons of vanadium pentoxide  $(V_2O_5)$ . Mined ore which failed to contain sufficient quantities of uranium were discarded at the mine sites. These tailing piles remain exposed at the sites. Several tons of tailings are believed to have been used as base material for neighboring roads and concrete.

The N-D mine was believed to be operated from 1952-1957. The exact name of the operating company or companies is not known at this time. This mine primarily employed strip mining techniques. The Navajo Nation estimate that over 11,110 tons of uranium ore was extracted from this operation.

#### III. ASSOCIATED HAZARDS

The ATSDR initiated a preliminary investigation at the sites to determine if they pose physical, chemical and/or radiological hazards. In summary, the ATSDR determined that the open pits and shafts do pose a significant physical hazard to the neighboring populations. The open shafts and pits are not fenced or secured and neighboring children may accidentally fall or get lost within these pits or shafts.

The ATSDR noted that the heavy metals associated with the weathering mine tailings may pose a significant environmental and health hazard. Heavy metals such as chromium, arsenic, vanadium, and zirconium may be leaching from the tailing piles and may be adversely affecting the groundwater quality of the region. In addition, neighboring populations may be exposed to wind blown heavy metal particulates.

Finally, the tailing piles contain elevated concentrations of radioactive material associated with the decay and degradation of uranium. Radioactive particulates and radon gas are likely to be migrating from the tailings. ATSDR believes that the neighboring population may be exposed to unsafe levels of radiation.

#### IV. ATSDR RECOMMENDATIONS

ATSDR has recommended action to assess and assist the local residents. ATSDR has recommended that an educational program be implemented to inform the neighboring population of the potential health effects of the mines. In addition, ATSDR has recommended that a more complete and detailed assessment be performed to assess the health impacts associated with the tailings.

ATSDR recommended that additional data be collected to characterize the amount and extent of contamination associated with the tailings. This would include collecting and analyzing soil, air and surface and groundwater samples for heavy metals and radioactivity. To investigate the radiation exposure of the neighboring population, ATSDR recommended the implementation of a personal radiation dosimeter program. Personal radiation dosimeters would allow ATSDR to estimate the external radiation exposure levels of the community. In addition, a complete biota, food crop and livestock study should be undertaken to evaluate the internal radiation exposure levels of the neighboring communities.

To implement ATSDR's recommendations, several Federal agencies such as the Bureau of Indian Affairs, Indian Health Services, EPA Superfund Program, EPA Office of Air and Radiation, Department of Energy, State of New Mexico and others will need to be involved with this project.

#### V. EMERGENCY RESPONSE ROLE

The Environmental Protection Agency Region IX, Emergency Response Section (ERS) has been tasked to perform the geochemical and georadiological study of the sites to assess the environmental and physical hazards of the area. ERS, accompanied by its Technical Assistant Team contractor, Ecology and Environment, are prepared to collect and analyze tailing, soil, air, surface water, run-off sediment and groundwater samples. EPA's Office of Air and Radiation, Las Vegas, Nevada, will be supporting ERS with their expertise in conducting radiation surveys and overseeing personal radiation safety.

An initial gamma radiation survey will be conducted by Colleen Petullo, OAR, to determine the external radiation hazards associated with the site. An "Exclusion" zone will be delineated by Collen Petullo, OAR health physicist, to restrict non 40 hr trained personnel and unauthorized people from access to the study areas. In addition, areas with gamma radiation levels exceeding 2.5 millirem/hr will be classified as "Hot" zones and personnel will not be allowed to work in these zones without direct supervision and approval of the health physicist. All personnel will be monitored exiting the study area. Instruments and protective gear will be monitored for radiation. Every effort will be made to avoid the generation of radioactive waste. A formal decontamination protocol will be implemented.

Physical hazards such as open shafts and pits will be delineated and flagged. An inventory to estimate the volume of potentially contaminated material will be collected.

Both surface and boring samples will be collected within the tailing piles and surrounding areas. Storm channel deposits will be collected to determine if rain run-off is acting as a mode of contamination transport. In addition, neighboring water well samples and, if possible, surface water samples will be collected and analyzed. All samples will be analyzed for heavy metals, radioactive isotopes and radioactivity. The samples will be collected pursuant to an approved sampling and work plan being drafted by Ecology and Environment. An extensive photographic record will be made during the assessment.

Areas of elevated gamma radiation will be delineated and used as potential monitoring stations for calculating radon flux measurements. These measurements will determine the amount of radon being emitted into the atmosphere from the tailings. If warranted a complete radon gas monitoring program above and down-wind of the tailing piles will be developed and implemented. Several carbon absorption test kits will be employed to capture the radioactive gas. Testing will be pursuant to the radon flux method outlined in 40 CFR Part 61. A domestic radon monitoring program and a biota/livestock sampling program has been recommended by ATSDR and ERS will try to coordinate these activities

will other Federal and Navajo agencies.

The assessment will be directed by the ERS On-Scene-Coordinator (OSC). The OSC will be consulting and working closely with the various other Federal and Tribal agencies participating in this investigation. The assessment is scheduled to begin on November 13, 1990. A meeting between ERS personnel and the Navajo Superfund program is scheduled on November 13, 1990 at 4:00 pm. The OSCs assigned to lead the assessment are Robert Bornstein (415-744-2298) and Robert Mandel (415-744-2290). The project Health Physist from OAR will be Colleen Petullo (702-798-2446). The TAT Project Leaders are Mary Sue Philips and Beverly Pester (415-777-2811).

Analytical samples will be sent to TMA/Eberline laboratory located in Albuquerque. Sample analysis will be determined by using a flow chart developed by OAR.

The results of the sampling program will be compared to both Federal and State Action levels governing radioactivity and heavy metals. The following radioactive standards will be employed:

o Drinking Water: 40 CFR 141

MCL for radium-226 and radium 228: 5 pCi/l

MCL for gross alpha particule activity (including radium-226 but excluding radon and uranium): 15 pCi/l

MCL for gross beta: 50 pCi/l

MPC (10 CFR 20) 9E-4 uCi/ml (U²³⁴)

8E-4 uCi/ml (U²³⁵)

1E-3 uCi/ml (U²³⁸)

o Soil: 40 CFR 192
Radium-226 in top 15 cm: not > 5 pCi/g over background
Radium-226 below 15 cm: not > 15 pCi/g over background

o Ambient Air: 40 CFR 192
Radon-222: Average over 1 year over disposal areas not to exceed 20 pCi/m²/sec (Radon Flux)
Annual average at residential areas not to exceed 0.5 pCi/m²/sec (Radon Flux)
Radon-222 in occupied buildings: not to exceed .03 WL over background

MPC (10 CFR 20): 1E-10 uCi/ml (U²³⁴) 1E-10 uCi/ml (U²³⁵) 7E-11 uCi/ml (U²³⁸)

o Gamma radiation survey standard: >= 100 millirem/year*

* Proposed Standard by the Presidential Working Group on Radiation Safety (DOE, HHS, ATSDR)

MCL = Maximum Contaminant Level
MPC = Maximum Permissible Concentration

Based on the results of the assessment, ERS will determine if

an immediate health risk exists. If the promulgated standards are exceeded and an immediate health risk is established, ERS will prepare an Action Memorandum pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300). If it is determined that a long term health risk is associated with the sites, ERS will refer this data to the Superfund Remedial Program. An emergency response action may include but is not limited to the following activities:

- o The physical removal or encapsulation of the tailing piles;
- o The proper closure of the mine pits and shafts;
- o The relocation of exposed population;
- o The supply of alternate water to the community;
- o The erecting of warning signs and a fence to restrict assess to the sites;
- o The application of a soil sealant to restrict the migration of contaminants from the sites.

If the NCP criteria for Removal Actions are met, an Action Memorandum will be forwarded to EPA Headquarters, Emergency Response Division to request funding approval. Headquarters approval is required because Removal Actions on Reservations have been determined to have "national" significance.

#### PROJECT CONTACTS

Dalamata Danis at 12	0. 0	
Robert Bornstein	On-Scene-Coordinator	415-744-2298
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Barbara Gross	Industrial Hygienist	415-744-1607
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Gavrav Rajen	Navajo Superfund	602-871-6859
Bill Nelson	ATSDR	415-744-2194
Mary Sue Philips	TAT Project Leader	415-777-2811
Beverly Pester	TAT QA Leader	415-777-2811
Vickey Radvila	TAT Member	415-777-2811

#### TRIP SCHEDULE

DEPARTURE: November 13, 1990 --- America West Flight HP431/HP202

OAKLAND TO ALBUERQUE Departs: 0700 hrs

Departs: 0700 hrs Arrives: 1140 hrs via Pheonix

RETURN: November 16, 1990 -- America West Flight HP640/HP10

ALBUERQUE TO OAKLAND Departs: 1705 hrs

Arrives: 2015 hrs via Pheonix

Hotel: El Rancho, Gallup, New Mexico -- 505-863-9311 Car: Heritz Car Rental - 4 wheel drive - #7611-079-A4A6 MAVAJO SUPERFUND PROGRAME

Nanabah Vandever St Report Reference 10 P. ANTONIO MARCH'92



### UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street San Francisco, Ca. 94105

January 29, 1991

Gaurav Rajen, Project Manager Navajo Superfund Progam Navajo Nation 43 Crest Road St. Micheals, Arizona 86511 JAN 31 1991 ATT Newsio dispertund Office

SUBJECT: Bluewater Uranium Mine Preliminary Assessment Data

Enclosed are the radionuclide, metal and gamma survey data collected by the Emergency Response Section (ERS) preliminary assessment, conducted on November 15-16, 1990, at the Brown-Vandever and Desiderio Uranium Mine Sites, located outside of Prewitt, Navajo Nation, New Mexico. This assessment was performed at the request of the Agency for Toxic Substances and Disease Registry (ATSDR) to identify if the Sites pose any immediate adverse environmental and health hazards.

#### Site Background

The Navajo-Brown Vandever (N-BV) and Navajo-Desiderio (N-D) mine sites are located within the Ambrosia Lake subdistrict of the Grants Uranium Mining District. The N-BV mine site encompasses approximately 155 acres, and the N-D covers 130 acres. The sites lie within a sparsely populated agricultural area.

Several families live on both mine sites. Approximately thirty people live on the N-BV site, including children, and approximately forty people live on the N-D site. The land is primarily utilized as grazing areas for the cattle, horses, sheep and goats.

Both mine sites consist of strip mine pits, tailing piles and open vent and mine shafts. There are presently no barriers prohibiting access to these mined areas.

ATSDR issued a Health Advisory for the sites on November 21, 1990. Since then, ERS has been consulting with Greg Demspey and Colleen Petullo, Office of Air and Radiation, Las Vegas and Bill Nelson, ATSDR and yourself.

Data

Figure 1 shows the locations of the mine sites. Figure 2 shows the Brown-Vandever Mine Site and Figure 3 shows the Desiderio Mine Site. Table 1 contains the gamma survey data. Table 2 lists the radionuclide data obtained from the water and soil samples. Figure 4 divides the Brown-Vandever Mine Site into four sections which were surveyed and sampled. Figures 5-8 show the sampling locations within each section of the Brown-Vandever Mine Site. Figure 9 shows the sampling locations from the Desiderio Mine Site. Appendix A contains the results of the Radon Flux experiment conducted at the Desiderio Mine Site. Appendix B contains the heavy metal sample results. Appendix C contains the laboratory data sheets.

#### Assistance ·

At this time, ERS has requested OAR, ERD and ATSDR assistance in interpreting the radionuclide assessment data for the purpose of determining if an imminent and substantial health risk exists at either of the sites. For instance, the data reveals that nearly all of the sampling points within the mined areas appear to exceed the promulgated standard for Radium-226, which should not exceed 5 pCi/g above background within the first fifteen centimeters of soil, as outlined in 40 CFR Section 192.12. We need help in determining if the sites pose an acute (need to do a removal action) or a chronic (remedial action more appropriate) health risk. One criterion that could be used to determine if a removal action is warranted is an increased carcinogenic health risk of 1 in 10,000 or more after a two year exposure. This criterion is based on the following:

- A) A risk of 1 in 10,000 is the high end of the risk range established by EPA in the NCP which requires a response action;
- B) It is estimated that it would take over two years for the remedial program to be able to address these sites since neither has yet to be placed on the NPL.

It is important to select a number or criteria that can be used on more than one site since there are many similar sites in Arizona and New Mexico. Our decision is likely to set a precedent for future potential removal actions at these type of uranium mine tailing sites. In addition, ATSDR must determine what steps they must undertake in response to their Health Advisory based on what we determine to do at these sites.

As we discussed, at this time, this data is for internal review and comments. Please, do not release the data to the public. In addition, I am concerned over the preschool water sample. It appears that there may be a potential lab/sampling

error. We are presently reviewing the laboratory information. However, to be on the conservative side, I recommend that this well be immediately resampled.

I look forward to working with you in the near future. Please contact me if you have any questions or concerns at 415-

Sincerely,

Robert Bornstein

On-Scene-Coordinator

cc: enclosures



#### TABLE 1 GAMMA RADIATION SURVEY DATA BROWN-VANDEVER MINE SITE, NAVAJO NATION

NOVEMBER 14-15, 1990 .
Operator - Collen Petullo Recorder - Robert Bornstein

Instrument ID# Calibration date Calibration Source

1 Ludlum 19 452663 11-08-90 Ra-226 10-15-90 2 Bicron 825481 Cs-137

Pu-239,Sr-90 3 Ludlum 12 140830 11-08-90

Pancake

#### Date 11/14/90 SECTION 1

Date 11/14/90 SECTION 1								
Inst.	Time	Station	Ground	Waist	Comments			
1 3	0900 0903	Background1	11 uR/hr 100 cpm	11 uR/hr 100 cpm	2.5 mi from site.			
1 3	0908 0910	Background2	11 uR/hr 100 cpm	11 uR/hr 100 cpm	1.0 mi from site.			
1	0930	Brown Home	13 uR/hr	14 uR/hr	stage area			
1 2	1000 1001	Station 1	35 uR/hr 25 urem/hr	36 uR/hr 25 urem/hr	Center of dirt road			
1 2	1003 1004	Station 2	130 uR/hr 70 urem/hr	135 uR/hr 60 urem/hr	near tree			
1 2	1007 1008	Station 3	90 uR/hr 50 urem/hr	N/A N/A	contact on ground			
1 2	1010 1011	Station 4	115 uR/hr* 75 urem/hr	100 uR/hr # 50 urem/hr				
1 2	1015 1017	Station 5	130 uR/hr 85 urem/hr	145 uR/hr 60 urem/hr				
1 2	1019 1020	Station 6	1200 uR/hr 800 urem/hr	800 uR/hr 400 urem/hr	In pit zone			
1 2	1028 1033	Station 7	40 uR/hr 20 urem/hr	44 uR/hr 25 urem/hr	Away from pit area			
1 2	1040 1044	Station 8	150 uR/hr 90 urem/hr	140 uR/hr 72 urem/hr				

Table 1. (Continued)

Inst.	Time	Station	Ground	Waist	Comments
24361	• • • •	D. CECTON	AT ORTIG	46796	COMMENTS
1 2	1055 1057	Station 9	190 uR/hr 120 urem/hr	170 uR/hr 90 urem/hr	
1 2	1105 1108	Station 10	1250 uR/hr 750 urem/hr	800 uR/hr 350 urem/hr	open area
1 2	1113 1115	Station 11	400 uR/hr 300 urem/hr	200 uR/hr 150 urem/hr	
1 2	1118 1120	Station 12	600 uR/hr 500 urem/hr	500 uR/hr 300 urem/hr	
1 2	1122 1124	Station 13	500 uR/hr 250 urem/hr	500 uR/hr 400 urem/hr	
1 2	1127 1128	Station 14	600 uR/hr 300 urem/hr	700 uR/hr 300 urem/hr	
1 2	1134 1136	Station 15	230 uR/hr 150 urem/hr	280 uR/hr 150 urem/hr	
1 2	1140 1141	Station 16	700 uR/hr 300 urem/hr	600 uR/hr 250 urem/hr	
1 2	1150 1151	Station 17	80 uR/hr 40 urem/hr	120 uR/hr 35 urem/hr	
1 2	1155 1156	Station 18	90 uR/hr 50 urem/hr	65 uR/hr 35 urem/hr	
1 2	1300 1303	Station 19 SECTION 2	700 uR/hr 450 urem/hr	600 uR/hr 350 urem/hr	
1 2	1306 1309	Station 20	900 uR/hr 650 urem/hr	800 uR/hr 500 urem/hr	on pad
1 2	1314 1315	Station 21	300 uR/hr 250 urem/hr	230 uR/hr 150 urem/hr	attic
1 2	1320 1321	Station 22	230 uR/hr 130 urem/hr	210 uR/hr 100 urem/hr	edge of pile
1 2	1330 1334	Station 23	120 uR/hr 40 urem/hr	50 uR/hr 40 urem/hr	

Table 1. (Continued)

Inst.	Time	Station	Ground	Waist	Comments
1 2	1346 1348	Station 24	220 uR/hr 120 urem/hr	220 uR/hr 110 urem/hr	
1 2	1350 1352	Station 25	500 uR/hr 250 urem/hr	400 uR/hr 175 urem/hr	
1 2	1358 1400	Station 26	300 uR/hr 170 urem/hr	300 uR/hr 170 urem/hr	
1 2	1405 1408	Station 27	250 uR/hr 150 urem/hr	200 uR/hr 150 urem/hr	
1 2	1320 1322	Station 28 SECTION 3	10 uR/hr 5 urem/hr	10 uR/hr 5 urem/hr	11/15/90
1 2	1330 1330	Station 29	N/A	13 uR/hr 10 urem/hr	at window of vent
1 2	1333 1334	Station 30	80 uR/hr 50 urem/hr	80 uR/hr 50 urem/hr	lots of stones
1 3	1337 1338	Station 31	75 uR/hr 300 uR/hr	Lgm micro	on casing in hole
1 2	1345	Station 32	350 - 90 uR/1 250 - 50 ure		
1 2	1355 1400	Station 33 SECTION 4	15 uR/hr 10 urem/hr	15 uR/hr 10 urem/hr	
1 2	1405 1407	Station 34	125 uR/hr 90 urem/hr	90 uk/hr 50 urem/hr	
1 2	1410 1411	Station 35	25 uR/hr 10 urem/hr	25 uR/hr 10 urem/hr	
1 2	1415 1417	Station 36	225 uR/hr* 130 urem/hr	110 uR/hr# 70 urem/hr	on wall face
1 2	1420 1423	Station 37	600 uR/hr 300 urem/hr	600 uR/hr 300 urem/hr	dug area
1 2	1430 1433	Station 38	240 uR/hr 200 urem/hr	200 uR/hr 240 urem/hr	

Table 1. (Continued)

Inst.	Time	Station	Ground	Waist	Comments
1 2	1440 1443	Station 39	18 uR/hr 10 urem/hr	18 uR/hr 10 urem/hr	
1 2	1446 1448	Station 40	700 uR/hr 600 urem/hr	600 uR/hr 300 urem/hr	
1 2	1452 1453	Station 41	500 uR/hr* 350 urem/hr	400 uR/hr# 250 urem/hr	

* On contact with rock/tailing outcrop

# 3 feet from contact

### DESIDERIO MINE SITE, NAVAJO NATION

NOVEMBER 15, 1990

Operator - Collen Petullo Recorder - Vicky Radvilla

Instrument ID# Calibration date Calibration Source
1 Ludlum 19 452663 11-08-90 Ra-226

1 Ludium 19 452663 11-08-90 Ra-226 2 Bicron 825481 10-15-90 Cs-137

3 Ludlum 12 140830 11-08-90 Pu-239, Sr-90

Pancake

#### Date 11/15/90 SECTION 1

Inst.	Time	Station	Ground	Waist	Comments	
1 3	0825	Background1	11 uR/hr 100 cpm	11 uR/hr 100 cpm	2.5 mi from site	
1 3	0830	Background2	11 uR/hr 100 cpm	11 uR/hr 100 cpm	1.0 mi from site	
1 2	0855 0856	Station 1	12 uR/hr 7 urem/hr	12 uR/hr 6 urem/hr	at pond site	
1 2	0857 0859	Station 2	18 uR/hr 8 urem/hr	18 uR/hr 8 urem/hr	at fense	
1 2	0940 0941	Station 3	10 uR/hr 5 urem/hr	10 uR/hr 5 urem/hr	at base station	
1 2	0955 0956	Station 4	20 uR/hr 7 urem/hr	24 uR/hr 7 urem/hr	large pit	

18111

Min

5.7

APPENDIX A

1.

November 30, 1998

Ms. Mary Sue Philp Ecology & Environment 169 Spear St. San Francisco, CA 94195

Subject: Results of Radon Flux Testing

Navajo Uranium Mine Sites

New Mexico

Dear Ms. Philp:

Scientific Analysis, Inc, is pleased to provide you with the results of 5g radon flux measurements performed on November 15-16, 199g on three Navajo uranium mine sites using the 4" charcoal canister device (SAACC). While the SAACC procedure is not an EPA approved method, side by side measurements using the SAACC and the EPA approved procedure (LAACC) demonstrate comparable results when respective arithmetic means are computed and compared with each other.

The arithmetic mean radon flux levels were 51.4, 67.8, and 47.7 pCi/m²-s, respectively for stations 5, 6, and 7. For comparison purposes, the 48 CFR Part 61 standard for operating uranium mill tailings piles limits radon emissions to 28 pCi/m²-s.

Individual flux results are presented in the attached Tables Tx where the prefix NU5 refers to Navajo Uranium Station 5, NU6 refers to Navajo Uranium Station 6, and NU7 refers to Navajo Uranium Station 7. Each table is divided into subparts (v) valid test results, (d) duplicate test results to demonstrate counting precision, and (b) "blank" results to check internal quality control. Based on counting results, measurements identified as NU5-20494, NU6-29429, and NU7-20433 are most likely blanks (i.e. unexposed SAACC).

Table QA outlines the quality assurance results. Sampling conditions such as ambient temperature and rainfall are unknown to SAI but are assumed to be within the limits prescribed in the SAACC procedure. In addition, a copy of the sample chain of custody form is included for your files.

If you have any questions regarding these results and this letter report, please do not hesitate to call me. All data and reports

Ms. Mary Sue Philp November 30, 1990 Page 2

will be treated as confidential and will not be released without your written approval.

Sincerely,

SCIENTIFIC ANALYSIS, INC.

Thomas R. Horton

Radiation Consultant

TH/rlr

attach: Table (4)

Table QA
Quality Assurance Results

Mine Stations	Completeness	Counting § Precision	Blank (Blind) Identification
Overall	166	g.2	•

^{*}All blanks (blinds) were presumably found and calculated to have an equivalent flux of zero.



# SUMMARY OF RADON PLUI COMPUTATIONS TABLE TV. VALID TEST RESULTS FOR TOP OF STACK Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

					/	4.744
Betector On Stack	Off Stack	Count Began	Counter Iff.	Gross Cats	Reckground	flux
#05-20384 11/15/90 11:38 am	11/16/90 10:17 am	11/20/90 09:14 am	0.1659	56136	616	52.9
E05-20385 11/15/90 11:40 am	11/16/90 10:17 am	11/20/90 09:26 am	0.1659	<b>65891</b>	616	62.3
EU5-20386 11/15/90 11:32 am	11/16/90 10:21 am	11/20/90 09:46 am	0.1659	37381	616	34.9
#05-20387 11/15/90 11:30 am	11/16/90 10:18 am	11/20/90 09:58 am	0.1659	38564	615	36.1
E05-20388 11/15/90 11:34 am	11/16/90 10:19 am	11/20/90 10:09 am	0.1659	41146	616	38.7
EU5-20389 11/15/90 11:37 am	11/16/90 10:18 am	11/20/90 10:20 am	0.1659	50799	<b>6</b> 16	48.1
EU5-20390 11/15/90 11:42 am	11/16/90 10:15 am	11/20/90 10:31 48	0.1659	41825	616	39.8
EU5-20391 11/15/90 11:44 am	11/16/90 10:16 am	11/20/90 10:42	0.1659	37511	616	35.7
WU5-20392 11/15/90 11:31 am	11/16/90 10:18 am	11/20/90 10:53	0.1659	72031	615	68.5
#U5-20393 11/15/90 11:30 am	11/16/90 10:21 am	11/20/90 11:04 am	0.1659	73480	616	69.7
MU5-20394 11/15/90 11:27 am	11/16/90 10:20 am	11/20/90 11:18 am	0.1659	67716	616	64.3
EU5-20395 11/15/90 11:23 am	11/16/90 10:20 am	11/20/90 11:31 am	0.1659	41909	816	39.5
MU5-20396 11/15/90 11:45 am	11/16/90 10:21 am	11/20/90 11:50 am	0.1659	133063	616	129
EU5-20397 11/15/90 11:44 am	11/16/90 10:22 am	11/20/90 12:01 pa	0.1659	124722	616	121
SU5-20398 11/15/90 11:40 am	11/16/90 10:21 am	11/20/90 12:13 pa	0.1659	26268	616	24.9
EUS-20399 11/15/90 11:41 am	11/16/90 10:21 am	11/20/90 12:26 pa	0.1659	70727	616	68.3
WU5-20400 11/15/90 11:48 am	11/16/90 10:13 am	11/20/90 12:39 pa	0.1659	21932	616	21.0
\$05-20401 11/15/90 11:45 am	11/16/90 10:17 am	11/20/90 12:56 pa	0.1659	27380	616	26.3
905-20402 11/15/90 11:51 am	11/16/90 10:13 am	11/20/90 01:06 pe	0.1659	19879	816	19.1
#U5-20403 11/15/90 11:48 am	11/16/90 10:23 am	11/20/90 01:18 pa	0.1659	28771	616	27.7

HOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M

HOTE: Humber of Flux Heasurements = 20; Average flux = 51.4





SUMMARY OF RADON FLUX COMPUTATIONS
TABLE 7d. DUPLICATE TEST RESULTS FOR TOP OF STACE
Scientific Analysis, Inc.; Montgonery, Alabama 36117

11/27/90

				-	• • • • • • • • • • • • • • • • • • • •			**/	61/34
Betector On S	tack	Off S	tack	- Count	Began	Counter Iff.	Gross Cats	Background	Flux
<b>E</b> U5-20390 11/15/90	11:42 an	11/16/90	10:15 am	11/21/90	11:40 an	0.1647	34465	570	39.9
EU5-20399 11/15/90	11:41 <b>a</b>	11/16/90	10:21 am	11/21/90	11:51 an	0.1647	59115	570	68.6

SOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M

HOTE: Sumber of Flux Measurements = 2; Average flux = 54.3





SUMMARY OF RADON FLUX COMPUTATIONS
TABLE TO. BLANK TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Betector --- On Stack --- Off Stack --- -- Count Begun --- Counter Eff. Gross Cats Background Flux 2005-20404 11/15/90 11:50 am 11/15/90 10:19 am 11/20/90 01:30 pm 0.1659 827 616 0.0

MOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq H

HOTE: Humber of Flux Measurements = 1; Average flux = 0.0



#### SUMMARY OF RADON FLUI COMPUTATIONS TABLE TV. VALID TEST RESULTS FOR TOP OF STACE Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

and a second sec					marguest),	TIEDERE OGITI		11/	21/30	
Setector	On St	tack	Off S	tack	Count	kşu —	Counter Eff.	Gross Cats	Background	Flux
<b>#</b> 06-20405	11/15/90	12:05 pa	11/16/90	10:23 am	11/20/90	01:41 pa	0.1659	18532	<b>6</b> 16	17.9
<b>E</b> U6-20406	11/15/90	12:03 pa	11/16/90	10:23 am	11/20/90	01:52 pa	0.1659	65963	616	65.2
<b>€</b> 06-20407	11/15/90	12:00 pm	11/16/90	10:23 am	11/20/90	02:03 pe	0.1659	88587	616	87.7
<b>■</b> 06-20408	11/15/90	12:01 pa	11/16/90	10:25 am	11/20/90	02:14 pa	0.1659	58818	616	58.1
<b>■</b> 06-20409	11/15/90	12:07 pa	11/16/90	10:27 am	11/20/90	02:25 pa	0.1659	45538	616	45.0
EU6-20410	11/15/90	12:06 pm	11/16/90	10:28 am	11/20/90	09:03 am	0.1638	43613	618	41.8
<b>E</b> U6-20411	11/15/90	12:02 pm	11/16/90	10:26 am	11/20/90	09:14 am	0.1638	84389	618	81.5
<b>T</b> U6-20412	11/15/90	12:04 pm	11/16/90	10:29 am	11/20/90	09:26 am	0.1638	62770	618	60.5
<b>■</b> U6-20413	11/15/90	11:59 am	11/16/90	10:30 am	11/20/90	09:46 48	0.1638	46516	618	44.6
<b>5</b> 06-20414	11/15/90	12:07 pm	11/16/90	10:31 am	11/20/90	09:58 am	0.1638	46848	618	45.2
<b>■</b> 06-20415	11. 15/90	12:10 pm	11/16/90	10:28 am	11/20/90	10:09 am	0.1638	57169	618	55.6
<b>#</b> 06-20416	11/15/90	11:55 am	11/16/90	10:25 am	11/20/90	10:20 an	0.1638	57660	618	55.7
<b>E</b> U6-20417	11/15/90	11:58 am	11/16/90	10:25 am	11/20/90	10:31 an	0.1638	146693	618	143
₩06-20418	11/15/90	11:57 am	11/16/90	10:25 am	11/20/90	10:42 as	0.1638	124072	618	121
#U6-20419	11/15/90	11:53 am	11/16/90	10:25 am	11/20/90	10:53 aa	0.1638	84129	618	81.8

BOTE: All times are local stack times; Counting time is D minutes; Flux is given in pCi/Sec-Sq M

HOTE: Bumber of Flux Seasurements = 15; Average flux = 67.0





SUMMARY OF RADOR FLUX COMPUTATIONS
TABLE Td. DUPLICATE TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgonery, Alabama 36117

11/27/90

Betector On S	tack	Off Stack	Count Began	Counter Eff.	Gross Cats	Background	Flux
EU6-20410 11/15/90	12:06 pa	11/16/90 10:28 am	11/21/90 11:40 am	0.1642	<b>3</b> 5937	634	41.9
<b>2</b> 06-20420 11/15/90	11:50 am	11/16/90 10:25 am	11/21/90 11:51 42	0.1642	<b>6</b> 25	634	0.0

HOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq H

MOTE: Sumber of Flux Measurements = 2; Average flux = 20.9





SURMARY OF RADON FLUX COMPUTATIONS
TABLE TO. BLANK TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Betector — On Stack — Off Stack — Count Begun — Counter Eff. Gross Cats Background Flux EU6-20420 II/15/90 11:50 an 11/16/90 10:25 an 11/20/90 11:04 an 0.1638 640 618 0.0

MOTE: All times are local stack times; Counting time is /D minutes; Flux is given in pCi/Sec-Sq M

NOTE: Number of Flux Measurements = 1; Average flux = 0.0



## SUMMARY OF RADON FLUI COMPUTATIONS TABLE TV. VALID TEST RESULTS FOR TOP OF STACE Scientific Analysis, Inc.; Montgonery, Alabana 36117

11/27/90

Setector On Stac	:t t:	Off S	tack	- Count	legu	Counter Eff.	Gross Cats	Sackground	Flux
<b>#</b> 07-20421 11/15/90 1	l2:14 pa	11/16/90	10:29 am	11/20/90	11:18 am	0.1638	40588	618	39.7
EU7-20422 11/15/90 1	2:16 pa	11/16/90	10:29 am	11/20/90	11:31 am	0.1638	67549	618	66.7
<b>E</b> U7-20423 11/15/90 1	12:18 pa	11/16/90	10:30 am	11/20/90	11:50 am	0.1638	53832	618	53.2
EU7-20424 11/15/90 1	12:22 pe	11/16/90	10:30 am	11/20/90	12:01 pa	0.1638	29053	618	28.6
<b>E</b> U7-20425 11/15/90 1	12:22 pa	11/16/90	10:30 am	11/20/90	12:13 pa	0.1638	37118	618	36.7
<b>E</b> 07-20426 11/15/90 1	12:19 pa	11/16/90	10:30 am	11/20/90	12:26 pa	0.1638	37697	618	37.3
EU7-20427 11/15/90 1	12:15 pm	11/16/90	10:30 am	11/20/90	12:39 pa	0.1638	42691	618	42.2
EU7-20428 11/15/90 1	l2:18 pa	11/16/90	10:33 am	11/20/90	12:56 pe	0.1638	55381	618	55.1
<b>E</b> 07-20429 11/15/90 1	12:20 pm	11/16/90	10:34 am	11/20/90	01:06 pa	0.1638	39554	618	39.2
EU7-20430 11/15/90 1	12:12 pa	11/16/90	10:35 am	11/20/90	01:18 pm	0.1638	41457	615	41.0
<b>E</b> 07-20431 11/15/90 1	12:24 pe	11/16/90	10:34 am	11/20/90	01:30 pa	0.1638	46276	618	46.3
TU7-20432 11/15/90 1	i2:26 pm	11/16/90	10:32 am	11/20/90	01:41 pa	0.1638	84987	618	85.9

BOTE: All times are local stack times; Counting time is /D minutes; Flux is given in pCi/Sec-Sq M

MOTE: Mumber of Flux Measurements = 12; Average flux = 47.7





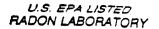
SUMMARY OF RADON FLUX COMPUTATIONS
TABLE 7d. DUPLICATE TEST RESULTS FOR TOP OF STACE .
Scientific Analysis, Inc.; Montgonery, Alabama 36117

11/27/90

Detector — On Stack — Off Stack — Count Begun — Counter Eff. Gross Cats Background Flux EUT-20430 11/15/90 12:12 pm 11/16/90 10:35 am 11/21/90 12:02 pm 0.1642 35074 634 40.9

BOTE: All times are local stack times; Counting time is /Ominutes; Flux is given in pCi/Sec-Sq H

MOTE: Number of Flux Measurements = 1; Average flux = 40.9





SUMMARY OF RADON FLUX COMPUTATIONS
TABLE TO. BLANK TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgonery, Alabama 36117

11/27/90

Betector — On Stack — Off Stack — Count Segun — Counter Eff. Gross Cats Background Flux EU7-20433 11/15/90 12:15 pm 11/16/90 10:30 am 11/20/90 01:52 pm 0.1638 622 618 0.0

BOTE: All times are local stack times; Counting time is /O minutes; Flux is given in pCi/Sec-Sq M

BOIL: Sumber of Flux Measurements = 1; Average flux = 0.0

# SCIENTIFIC ANALYSIS, INC.

## CHAIN OF CUSTODY RECORD

## Radon Flux Testing

Job Name: Ecology & Environment - 1	Vavajo Kramin mue Siter
Samplers (Name and Signature): Many &	e Dr. 6 sundy
	y Pester Devellation
	The state of the s
Sample Locations/Sample ID Numbers (Co.	llector Numbers):
-#20384 to #20433	
Sample Type: Exposed Charcoal in Plas	tic Container
Total Number of Samples: 50	
Collection Date: 11/5/90 - to	11/16/90
7	
Relinquished By (Name and Signature):	Mary Sie Phile
	world
Date/Time:	Will Go
Date/IIme.	
Received By (Name and Signature):	Faith ann ynewholter
	Food are mcWhater
Date/Time:	11-19-90 10:00 am
·	£
Relinquished By (Name and Signature):	
	•
Date/Time:	
Dece,	
Received By (Name and Signature):	
Date/Time:	

# SCIENTIFIC ANALYSIS, INC.

## CHAIN OF CUSTODY RECORD

# Radon Flux Testing

to some Edd + Fully +	
JOB Name: Ecology & Environment -1	Vavajo Kramin mue Sites
Samplers (Name and Signature): Mary &	ie Trilo Misty
Beven	VPester Purel State
Sample Locations/Sample ID Numbers (Co.	The state of the s
-#20384 to #20433	riector numbers):
Sample Type: Exposed Charcoal in Plas	tic Container
Total Number of Samples: 50	
Collection Date: 11/5/90 - to	11/16/90
Relinquished By (Name and Signature):	Mary Sue Phile
	/who
Date/Time:	11/16/90
	1 1
	9.11 a. [Mille]
Received By (Name and Signature):	Faith an Mewhoster
Received By (Name and Signature):	Faith an Mewhorter Faith are McWharter
Received By (Name and Signature):  Date/Time:	
Date/Time:	Sant au meWhate
	Sant au meWhate
Date/Time:	Sant au meWhate
Date/Time:	Sant au meWhate
Date/Time:  Relinquished By (Name and Signature):  Date/Time:	Sant au meWhate
Date/Time:  Relinquished By (Name and Signature):	Sant au meWhate
Date/Time:  Relinquished By (Name and Signature):  Date/Time:	Sant au meWhate
Date/Time:  Relinquished By (Name and Signature):  Date/Time:	Sant au meWhate

# APPENDIX B

IZA 1BA Page 2

Received: 12/06/90

TMA Inc.

REPORT

Work Order # A0-12-025

# SAMPLE IDENTIFICATION

19	19A
50	20A
51	219
55	W1
21	W1 Dulpicate
55	W1 Spike
25	Wi Spike Duplicate
53	MS
24	W3
25	W4
26	W5
27	W6
28	W7

·

01/21/91 15:49:23

Page 3

IMA INC.

KEPUKI

Work Urder # AU-12-U25

Received: 12/06/90

Results by Sample

SAMPLE ID 01A AREA 20

FRACTION 01A TEST CUDE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90

Category ____

AYEA

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	\ DETECTION
ELEMENT ,	METHOD	RESULT	LIMIT
Chromium	<b>IC</b> P	ND	2
Vanadium	ICP	474.	3
Titanium	ICP	26.	1
Magnesium	ICP	277 <b>0</b> .	22
Manganese	ICP	240.	1
Barlum	ICP	221.	1
Aluminum	ICP	4107.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.6	Ø. 1
Selenium	FURNACE	09	0. 2
Strontium	FLAME	150	5
Lead	FURNACE	<b>17.</b> 9	O. 1

rage 4

ITIA INC.

KETUKI

MALK ALARL # WALTE

Received: 12/05/70

Results by Sample

SAMPLE ID VIA duplicate Areado

FRACTION 01B TEST CODE METALS NAME METALS ANALYSIS Date & Time Collected 11/14/90

Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	465.	3 6 1 1 1
Titanium	1CP	9.	1470000 400000
Magnesium	ICP	1860.	.22
Manganese	ICP	250.	<b>一点有一个</b>
Barium	ICP	154.	
Aluminum	ICP	3360. _s	Stringer commences
Molybdenum	ICP	ND 🎊	4
Arsenic	FURNACE	1.8	0.1
Selenium	FURNACE	1. 5 (3)	0.2
Strontium	FLAME	180. 📆	5
L.ead	FURNACE	14. 4	0.1

rage o

HIM THE.

INC. UILL

THIR WINEL IS IN AM MINE

Results by Sample

SAMPLE ID UIA Spike

Received: 12/06/90

FRACTION <u>01C</u> TEST CODE <u>METALS</u> NAME <u>METALS ANALYSIS</u>
Date & Time Collected <u>11/14/90</u> Category

Date Prepared 12/20/90 Date Analyzed 01/0//91

Analyst REM	. UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT 4540000
Chromium	ICP	137.	2
<b>Vanadi</b> um	ICP	738.	3/19/2019
Titanium	ICP	139.	1675
Magnesium	ICP	4130.	22
Manganese	ICP	453,	1.4
Barium	ICP	368.	A 15 15 15 15 15 15 15 15 15 15 15 15 15
Aluminum	ICP	12300.	311 311 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Molybdenum	ICP	154. 🎊	
Arsenic	FURNACE	NA (A)	THE OF THE STATE O
Selenium	FURNACE	NA //	0.2
Strontium	FLAME	NA NA	5
Lead	FURNACE	NA 🐇	Oct Market

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Results by Sample

SAMPLE ID <u>01A</u> Spike Duplicate

FRACTION 01D TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	ME THOD	RESULT	LIMIT ON STATE
Chromium	1CP	139.	2
Valiadium	ICP	791.	3 4 7 6 5 6
Titanium	ICP	97.	1
Magnesium	ICP	4540.	22 2 3 1 1914
Manganese	1CP	461.	102
Barium	1CP	408.	
Aluminum	ICP	13950. 🔏	3
Molybdenum	ICP	150. 🔬	<b>电影音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音音</b>
Arsenic	FURNACE	NA NA	0 1
Scleniom	FURNACE	NA	15 0. 2 13 33 A
Strontion	FL.AME	NA / F	5
Lead	FURNACE	NA SE	0.1

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Received: 12/06/90

Results by Sample

SAMPLE ID UZA Area 22

TEST CODE METALS NAME METALS ANALYSIS FRACTION 02A Date & Time Collected 11/14/90 Category

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Date Prepared 12/20/90 01/07/91 Date Analyzed

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	1CP	NA	2
Vanadium	ICP	105.	3 🖍
Titanium	ICP	20.	40 Mills 19 Mills
Magnesium	ICP	1300.	22
Manyanese	ICP	146.	
Barium	ICP	86. 2	
Aluminum	ICP	2120.	100 3
Molybdenum	ICP	ND .	4
Arsenic	FURNACE	Ø. 8 🕺	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	162.	77 5
l.ead	FURNACE	4. 1	OF D. 1

Received: 12/05/90

Results by Sample

SAMPLE ID 03A

Hrea 23

FRACTION 03A

TEST CODE METALS NAME METALS ANALYSIS Date & Time Collected 11/14/90

Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT #WAREA
Chromium	ICP	ND .	2
Vanadium	ICP	<b>53. 4</b> ;	3 / 10 10 10 10 10 10 10 10 10 10 10 10 10
Titanium	ICP	15. Ø	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Magnesium	ICP	993.	22
Manganese	ICP	151.	
Barium	ICP	105.	
Aluminum	ICP	1830.	A Sale
Molybdenum	ICP	ND *	4
Arsenic	FURNACE	0.7 學	0.1
Selenium	FURNACE	୍ଡ. ଅ	0.2
Strontium	FLAME	103.	1975 <b>1</b> 772 1
l.ead	FURNACE	4. 1	0.1

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Received: 12/06/90 Results by Sample

SAMPLE ID 04A

area 25

FRACTION <u>04A</u> TEST CODE <u>METALS</u> NAME <u>METALS ANALYSIS</u>

Date & Time Collected <u>11/14/90</u> Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	1CP	ND	2
Yanad i um	1CP	8. 28	3 (1977)
Titanium	1Ch	10.8	100000000000000000000000000000000000000
Magnesium	1CP	612.	22
Manganese	ICP	142.	
Barium	ICP	76. <b>4</b>	
Aluminum	ICP	1240.	2003
Molybdenum	ICP	ND ,	
Arsenic	FURNACE	0.5	0.11
Selenium	FURNACE	<0. 2 👸	0.2
Strontium	FLAME	24.3	2 5 3 3 3 1 N
Lead	FURNACE	1. 7	40 0.1 Haddish

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Received: 12/06/90

Results by Sample

SAMPLE ID 1854 Area Le

FRACTION U5A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst RCM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	186.	3
Titanium	ICP	52. 8	
Magnesium	1CP	1800.	22
Manganese	ICP	226.	
Barium	ICP	196.	6.166
Aluminum	ICP	4210.	A Part of the second of the se
Molybdenum	ICP	מא	4
Arsenic	FURNACE	Ø. 8	0.1
Selenium	FURNACE	<0. 2	130.2
Strontium	FLAME	182.	127 5
L.ead	FURNACE	9. 2	0.1 W. 120

rage 11

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Results by Sample

SAMPLE ID WAA

Received: 12/05/90

area 10

FRACTION 06A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90

Category

Date Prepared 12/20/50 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT ACCOMEN
Chromium	ICP	ND	2
Vanadium	1CP	<b>185</b> .	3/4 3/5 37 (2)
Titanium	ICb	40.	1
Magnesium	ICP	2000.	22
Manganese	ICP	229.	2.1
Barium	ICP	<b>79</b> .	
Aluminum	ICP	3640. A	3 3
Molybdenum	ICP	ND 🐧	3.44 等人在心中的
Arsenic	FURNACE	Ø. 8	0.133
Selenium	FURNACE	<0.2 //3	0.2
Strontium	FLAME	154.	5 43 43
l.ead	FURNACE	8.3	0.·1 Fishand

rage 12 Received: 12/06/90 ITIM ITIL.

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MOLK OLOGE # WALTS-ASD

Results by Sample

SAMPLE ID 07A

area 11

FRACTION <u>07A</u> TEST CODE <u>METALS</u> NAME <u>METALS ANALYSIS</u> Date & Time Collected 11/14/90

Category _

Date Prepared 12/20/90 Date Analyzed W1/07/91

	•		
Analyst REM	UNITS	mg/Kg	
ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	847.	3 / 100 100
Titanium	ICP	15. 9	1560007 19384
Magnesium	ICP	2580.	.22 7 7 7 7 1
Manganese	ICP	273.	engle Gala
Barium	ICP	200.	
Aluminum	ICP	4320.	13/3
Molybdenum	ICP	ND	ALLE A STATE OF AN
Arsenic	FURNACE	1.7	AND THE PARTY OF T
Selenium	FURNACE	<0.2 🐴	0.2
Strontium	FLAME	15. 3	5
Lead	FURNACE	26. 6	0.·1

aye to Received: 12/05/90 1. 11 4115.

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Results by Sample

SAMPLE ID WEA

Wash S. of fesidences

Date & Time Collected 11/14/70

FRACTION UBA TEST CODE METALS NAME METALS ANALYSIS

Category

12/20/90 Date Prepared Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	9. 63	3 4 3 7 7 3 3
Titanium	ICP	25. 3	
Magnesium	ICP	1154.	22
Manganese	ICP	105.	
Barium	ICP	5B. 5	
Aluminum	ICP	2970.	A STATE OF THE STA
Molybdenum	ICP	ND	
Arsenic	FURNACE	1.4	0.516
Selenium	FÜRNACE	<0.2	0.2
Strontium	FLAME	25. 5	27 5
Lead	FURNACE	21.9	Ø.·1

rage 17

Received: 12/06/90

Results by Sample

HILL ALLE

SAMPLE ID 119A Road to B-V

FRACTION <u>09A</u> TEST CODE <u>METALS</u> NAME <u>METALS ANALYSIS</u>

Date & Time Collected <u>11/14/90</u> Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	· UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	
Chromium	ICP	ND	2
Vanadium	ICP	6. <b>0</b> 7	3,444 (1)
litanium	ICP	25. 1	1
Magnesion	ICP	1480.	22
Manganese	ICP	2580.	14. 16. 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Barīum	ICP	4930.	<b>6.1</b> 1
Aluminum	ICP	3060.	7 3 Julius 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Molybdenum	ICP	ND	4
Arsenic	FURNACE	Ø. 8	0:1
/ Selenium	FURNACE	<0.2	0. 2
Strontium	FL AME	35. 1	5
Lead	FURNACE	3. 9	Parallal Carallal

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ITIM THE.

KETUKI

Results by Sample

Received: 12/Ma/90.

SAMPLE ID 194 On Road to Desiderio

Date & Time Collected 11/15/70

FRACTION 10A TEST CODE METALS NAME METALS ANALYSIS

Category

12720790 Hate Prepared 01/07/91 Date Analyzed

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	10.4	3 (6 ) (8 )
Titanium	ICP	90. 3	
Magnesium	ICP	2170.	22
Manganese	ICP	181.	A1 334
Barium	ICP	124.	
Aluminum	ICP	5530.	A BANKA
Molybdenum	ICP	ND ,	
Arsenic	FURNACE	1. 8 🐧	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	22. 6	<b>1</b> 5
l.ead	FURNACE	5. 9	16 01 (Call 16)

rage 16

ITIA INC.

KETUKI

CPOLY 1-04 & Jabun 14-050

Received: 12/06/90

Results by Sample

Corral

Mine Pit Near FRACTION 11A TEST CODE METALS NAME METALS ANALYSIS Date & Time Collected 11/15/90

Category _

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT POGRAZIA
Chromium	ICP	ND	2
Vanadium	ICP	5. 67	3 / 5 / 6 / 6
Titanium	1CP	41.3	1988
Magnesium	ICP	2150.	22 35 BENE
Manganese	İCP	14H.	£144
Barium	ICP	91. Ø	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Aluminum	ICP	3970. /	30.
Molybdenum	ICP	ND S	4
Arsenic	FURNACE	0.1	0.11
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	64.0	No salah
Lead	FURNACE	2.4	0.1

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KETUKI

MOLK OLGEL # WOLIS-055

Received: 12/06/90

Results by Sample

SAMPLE ID 12A

Cartidge areas Date & Time Collected 11/15/90 Category

12/20/90 Date Prepared Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	NETECTION.
ELEMENT	METHOD	RESULT	DETECTION LIMIT #78602570
Chromium	1CP	ND	2
Vanadium	ICP	11.0	3 (5) (6)
Titanium	ICP	23. 1	141136
Magnesium	1 C P	2450.	.22
Manganese	ICP	136.	
Barium	ICP	132.	
Aluminum	ICP	4000.	
Molybdenum	ICP	ND	
Arsenic	FURNACE	5. 2	
Selenium	FURNACE	<0.2	0.2
Strent1um	FLAME	116.	3. J
Lead	FURNACE	9. 5	6. 1 Table

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INCH WINE

Received: 12/06/90

Results by Sample

Padon Cort areas FRACTION 13A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category Category ____

Date Prepared 18720790 Date Analyzed 01/07/91

	•		ì	•
Analyst REM	UNITS	mg/Kg	DETECTION	•
EL EMENT	METHOD	RESULT	DETECTION LIMIT	
Chromium	ICP	ND	2	
Vanadium	ICP	10.7	3 6 5 6 6 6	
Titanium	ICP	39. <b>8</b>	1	
Magnesium	10P	2440.	,22	
Manganese	ICP	245.		
Bariom	1(:P	104.		
Aluminum	10b	3720.	A 3	
Molybdenum	ICP	ND .	400	
Arsenic	FURNACE	10. 2	0.1	
Selenium	FURNACE	<0.2	0.2	
Strontion	FL AME	139.	7 S	1
Lead	FURNACE	7. Ø	in 0.1 Gillialan	1

rage 17

ITIM L..L.

REFURI

MALK ALARL & WALTSLAST

Received: 12/05/90

Results by Sample

SAMPLE 10 14A

Hatron 11

FRACTION 14A TEST CODE METALS

Date & Time Collected 11/15/90

TEST CODE METALS NAME METALS ANALYSIS

Category _

Date Purposed 10/20/90 Oate Analyzed 01/0//91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT ANNONES
Chromium	ICP	ND	2
Vanadiom	ICP	11. 2	3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Titanium	ICP	55. 1	16.00
Magnesium	ICP	2049.	22
Manganese	ICP	131.	1
Batiom	ICP	6 <b>9</b> . 7	
Aluminum	1CP	4000.	334
Molybdenum	ICP	ND	4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Arsenie	FURNACE	1. 4	0.1
Selenium	FURNACE	Ø. 2	0.2
Strontiva	FLAME	119.	5 5
Lead	FURNACE	3. 3	0,1

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Results by Sample

SAMPLE ID 15A

FRACTION 15A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12720790 Date Analyzed 91707791

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	2
Vanadium	1CP	9. 43	3 ( ) ( )
Titanium	ICP	6Ø. 1	164657 1744
Magnesium	ICP	2130.	22 337
Manganese	ICP	137.	
Barium	ICP	58. 4	
Aluminum	ICP	4370.	ANION MODERA
Molybdenum	ICP	ND	
Arsenic	FURNACE	1. 5 ,6	0.1
Selenium	FURNACE	<0. 2	15 0. 2 (L. 17)
Strontium	FLAME	129.	
t_ead	FURNACE	3. 1	267 0.·1 Section .
			•

rage 21 Received: 12/06/90 ITIM ITIL.

KETUKI

MOLK ALGEL # 40-15-052

Results by Sample

SAMPLE ID 16A

FRACTION 16A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION	1
ELEMENT	METHOD	RESULT	LIMIT	
Chromium	ICP	ND	2	4
Vanadium	ICP	6. 85	3 (1) (1)	`;
Titanium	ICP	49. 5	14347 7034	
Magnesium	ICP	1500.	221	
Manganese	ICP	115.		
Barium	ICP	62. 3		
Aluminum	ICP	3920.	A 3/1	
Molybdenum	ICP	ND &	4	
Arsenic	FURNACE	1 0	0.123	ļ
Selenium	FURNACE	<0.2	0. 2	}
Strontlem	FL AME	21.3	197 <b>5</b> 1988	h
l.ead	FURNACE	2. 9	<b>6.1</b>	A

: age 22 Received: 12/06/70 IIIM LIIL.

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Results by Sample

SAMPLE ID 17A

FRACTION 17A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90

Category

Oate Prepared 1.7/20/90 Date Analyzed 03/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	10.8	3 4 1 1 1 1 1 1 1
Titanium	ICP	46. <b>3</b>	100
Magnesium	1CP	1830.	22
Manganese	ICH	143.	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Barium	1CP	20. 5	1
Aluminam	ICP	3450.	133
Molybdenom	ICP	ND	4
Arsenic	FURNACE	1. 5	0.1
Selentum	<b>FURNACE</b>	<Ø. 2	0.2
Strontium	FLAME	227.	5
Lead	FURNACE	2.4	01

. वपुष्ट दच Received: 12/06/90 THE AHL.

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Results by Sample

SAMPLE ID 184

FRACTION 18A TEST CODE METALS NAME METALS ANALYSIS Date & Time Collected 11/15/90

Category ____

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12720770 Oate Prepared Pate Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2 / 1
Vanadium	ICP	7. 59	3
Titanium	ICP	28. 9	1400207 10.497
Magnesium	1CP	1400.	22
Manganese	ICP	109.	112 6
Barium	ICP	90. B	
Aluminum	ICP	3450.	1.13 12 1 1 1 1 1 1 A
Melybdenum	ICP	ND	41
Arsenic	FURNACE	1.2	
Selenium	FURNACE	<0.2	0.2
Strontlum	FLAME	23. Ø	5 Sec. 3
l.ead	FURNACE	3. 0	0.1

rage kt Received: 12/96/90 Iria IIII.

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MOLK CLOSE # WALTSLAST

Results by Sample

SAMPLE ID 196

FRACTION 19A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90 Date Analyzed \$1/07/71

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	LIMIT TON
Chromium	ICP	ND	2
Vanadium	ICP	<b>8</b> 9. <i>9</i>	3 / 1994
Titaniom	ICP	12.0	19 19 19 19 19
Magnesium	1CP	1310.	.22
Manganese	1CP	118.	A1390
Rarium	ICP	205.	AT 188
Aluminum	ICP	2120.	A 3 3 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Molybdenum	ICP	ND /	4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Arsenic	FURNACE	0.7	Da I
Selenium	FURNACE	<0.2	0.2
Stronlium	FL AME	95. Ø	145 <b>5</b>
Lead	FURNACE	1. 9	0.1 3 mill

Received: 12/06/90.

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MULK MINEL B UN TE NET

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Results by Sample

SAMPLE ID 2014

FRACTION 20A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/Kg	DETECTION
ELEMENT	METHOD	RESULT	CIMIT CONTRACTOR
Chromium	ICP	ND	2
Vanadium	ICH	<b>95.</b> 3	3 / 1/2
litanium	ICP	10.7	19 337 500
Magnesium	ICH	1130.	22
Manganese	ICP	112.	
Barium	ICP	201.	
Aluminum	ICP	1740.	23 3 X
Molybdenum	ICP	ND /	4
Arsenic	FURNACE	Ø. 8 🔑	0.11
Selenium	FURNACE	0. 5	0.2
Strontium	FLAME	103.	5 200
Lead	FURNACE	2. 7	27 01 CUMB

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Results by Sample

SAMPLE ID 21A

FRACTION 21A TEST CODE METALS NAME METALS ANALYSIS Date & Time Collected 11/15/90

Category

nate Prepared 1078/0790 Date Analysis 01/0//91

	Analyst REM	UNITS	mg/Kg	DETECTION
	ELEMENT	METHOD	RESULT	LIMIT
•	Chromium	ICP	ND	2
	Vanadium	ICP	1410.	3 /2/2017
	Titanium	ICP	22, 5	1 3 3 3 3 4
	Magnesium	ICP	1930.	.22
	Manganese	ICP	225.	- 745 To \$1504
	Barium	ICP	65. <b>0</b>	(A) 1 (A) (A) (A)
	Aluminum	ICP	3320.	3
	Molybdenum	ICP	ND	4.33.4.33.4.34.34
	Arsenic	FURNACE	6.0	0.1
	Selenium	FURNACE	1.4	0.2
	Strontium	FL.AME	22. 6	5
	Lead	FURNACE	23. 1	15 V O. 1 Ciffelial

. age 67 Received: 12/06/90 HIM THE.

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MAIN MINCI E UN TE NET

Results by Sample

SAMPLE ID WI

FRACTION 22A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90 Date Analyzed 31/07/91

Analyst REM	UNITS	mg/L	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0, 01
Magnesium	ICP	11. 7	(D. 22)
Manganese	ICP	. 103	(0) 01 1 1 1 A
Barium	ICP	ND	3 0 01 X
Aluminum	ICP	ND	6 0 03
ហែចរប្រជាខាល់	ICP	. ชีวี2	0.04
Arsenic	FURNACE	0.003	0 001
Selenium	FURNACE	< 0. 802 🐪	0.002
Strontium	FLAME	11. 2	(A)
Lead	FURNACE	0. 002	0.0001 LANGE

. ugc 20 Received: 12/06/90

Results by Sample

SAMPLE 1D Wi Dulpicate

FRACTION 22B TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/L.	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	0. 02
Vanadium	ICP	ND	0,03,5
Titanium	ICP	ND	0.01
Magnesium	ICP	11. 2	0.22
Manganese	ICP	. 1	40.01
Barium	ICP	ND	f. 0. 01
Aluminum	ICP	. 19	0.03
Molybdenum	ICP	. <b>05</b>	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FL.AME	11.00	0.05
Lead	FURNACE	Ø. ØØ2	0.0001 Walker

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IIIA INC.

KETUKI

CPM-TT-MH # JODJN #JOM

Received: 12/05/90

Results by Sample

SAMPLE ID WI Spike

FRACTION 22C TEST CODE METALS NAME METALS ANALYSIS Category

Date & Time Collected 11/16/90

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/L	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	Ø. 85	0.02
Vanadium	ICP	Ø. 93	0.03
litanium	ICP	0.99	0. 01
Magnesium	ICP	12. 3	0.22   Line 183
Manganese	1CP	1. Ø	g 0. 01
Barium	ICP	0.76	A 0, 001
Aluminum	îcp	G. 96	6 003
Molybdenum	ICP	1.00	0.04
Arsenie	FURNACE	NA .	0.001
Sclenium	FURNACE	NA	0.002
Strontium	FL AME	NA	76 a. 05
lead	FURNACE	NA	0:0001

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Results by Sample

SAMPLE ID WI Spike Duplicate

FRACTION 22D TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12720/90 Date Analyzed 01/07/91

Heceived: 12/05/70

Analyst REM	UNITS	mg/L ~	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	Ø. 84	0. 02
Vanadium	ICP	0.89	0. 03
Titanium	ICP	0.99	0. 01
Magnesium	1Cb	12, 27	<b>0. 22</b>
Manganese	ICP	Ø. 99	<b>. 0. 01</b>
Barium	ICP	Ø. 73	6 <b>0.01</b>
Aluminum	ICb	1. 3	0,03
Molybdenum	ICP	1. Ø	0.04
Arsenie	FURNACE	NA	0.001
Selonium	FURNACE	NA	.0.002
Strontium	FLAME	NA	0.05
Lead	FURNACE	NA	0.0001

tage 31

IMA INC.

KEPUKI

Work Urder # AU-12-025

Received: 12/05/90

Kesults by Sample

SAMPLE ID WA

FRACTION 23A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

•		
UNITS	mg/L	DETECTION
METHOD	RESULT	DETECTION LIMIT
1CP	ND	Ø. Ø2
ICP	ND	0 03
ICP	ND	0.01
1CP	2.08	0. 22
1CP	ND	A 0. 01
1CP	ND	Å Ø. Ø1
1CP	. 042 6	0.03
ICP	ND	0.04
FURNACE	ND ;	0.001
FURNACE	ND "	0.002
FLAME	ND 3	7 Ø. Ø5
FURNACE	0.013	0.0001
	METHOD  ICP ICP ICP ICP ICP ICP ICP FURNACE FURNACE FLAME	METHOD RESULT  ICP ND ICP ND ICP 2 08 ICP ND

' ' ' '	₩.4	
Recel	ved:	12/06/90

Results by Sample

SAMPLE ID WI

FRACTION 24A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90

Category

Date Prepared 12/20/90 Inte Analyzed M1/07/91

Analyst REM	UNITS	mg/L	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.63
Titanium	ICP	ND	0.01
Magnesium	ICP	1. 76	0.227
Manganese	ICP	ND	0.01
Barium	ICP	0.03	0.01
Aluminum	1CP	ND	0.03
Molybdenum	ICP	ND .	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0. 002
Strontium	FL AME	0.12	Ø. Ø5
Lead	FURNACE	ND	

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Results by Sample

CAMPLE II) WA

Received: 12/06/70

FRACTION 25A TEST CODE METALS NAME METALS ANALYSIS

Date & lime Collected 11/16/90

Category

Date Prepared 12/20/90 Date Analyzed 01/07/91

Analyst REM	UNITS	mg/L	DETECTION
ELEMENT	METHOD	RESULT	LIMIT
Chromium	ICP	ND	0. 02
Vanadium	ICP	ND	0.03
fitaniom	ICP	ND	0. 01
Magnesium	1012	ND	,0. 22
rlanganes e	10h	ND	. 0. 01
Bariom	ICP	Ø. Ø3	. 0. 01
Aluminom	ICP	ND	A. 0. 03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Gelenium	FURNACE	ND ·	0.002
Strontium	FLAME	2. 55	0.05
i_ead	FURNACE	ND	0.0001

: age 34

tha the.

KEPUKI

MOLK FLOGL # MA-15-N52

Hece1ved: 12/M6/90

Results by Sample

SAMPLE ID VID

FRACTION 26A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Onte Prepared 12/20/50 Outr Analyzed 01/07/51

#### Analytical Test Results - METALS

Analyst REM	UNITS	mg/L	
ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	1CP	ND	0.02
Vanadium	1CP	ND	0.03
litanium	1CP	ND	0. 01
Magnesium	ICP	5. 47	,0,122
Manganese	ICP	Ø. Ø3	0.01
Barium	ICP	4. 79	A 0. 01
Aluminum	ICP	6. 51	0.03,
Molybdenum	ICP	ND /	<b>0.04</b>
Arsenic	FURNACE	ND	. 7.0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	0. 26	0. 05
Lead	FURNACE	0. 005	6 0.0001 minimal

eceived: 12/06/9%

11401 ABS.

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Results by Sample

流程压 肋 胁

FRACTION 27A TEST CODE METALS NAME METALS ANALYSIS

Date & lime Collected 11/16/90 Category

Pate Prepared 12/20/90 Pate Analyzed 01/07/91

#### Analytical Test Results - METALS

Analyst REM	. etinu	mg/L	
ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	П	0. 02
Vanadium	ICh	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	ND	<b>0.</b> 22
Manganese	ICP	ND	0.01
Barium	1CP	0.03	0. 01
Aluminum	ICP	Ø. Ø3	A . 0. 03
Molybdenum	ICP	ND ,	<b>らい。04</b> 位
Arsenic	FURNACE	ND 25	0.001
Selenium	FURNACE	ND .	35 0. <b>002</b>
Strontium	FLAME	Ø. 12 .	0.05
Lead	FURNACE	Ø. ØØ6	2 0.0001 Care

Received: 12/05/90

Results by Sample

SAMPLE ID WY

FRACTION 28A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 100207791

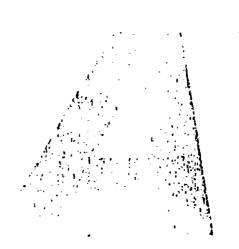
#### Analytical Test Results - METALS

Analyst REM	UNITS	mg/L	DETECTIO	
ELEMENT	METHOD	RESULT	DETECTIO	N
Chromium	ICP	ND	Ø. Ø2	
Vanadium	ICP	Ø. 22	0.03	
Titaniom	1CP	ND	0. 01	
Magnestum	ICP	1. 61	0. 22	
Manyanese	ICS	0.02	0.01	
Barium	ICP	ND	Ø. Ø1	•
Aluminum	ICP	1.06	0.03	•
Molybdenum	ICP	ND .	0. 04	٠, '
Arsenic	FURNACE	ND	0.001	
Selenium	FURNACE	ND	0.002	
Strontium	FLAME	0.12	Ø. Ø5	
l.ead	FURNACE	Ø. ØØ6	0.0001	C.

NonReported Work

# FRACTION AND TEST CODES FOR WORK NOT REPORTED ELSEWHERE

015	1	305010	AS_SCD	MPREPS
OTR	1	395010	AS_SLD	MPREPS
SHIC	1	1835010	AS_SED	MPREPS
040	j	010000	AS_SED	MPREPS
13776	1	305010	ASTSED	MPREPS
OBA	1	005017	AS_SED	MPREPS
947	1	วเตรเต เก	AS_SUD	MPREPS
954	1	305010	AG_ 50D	MPREP5
06A	J	0193910	ASUSED	MPREPS
97A	ı	005010	AS_SED	MPREPS
$\mathcal{G}(\mathcal{H}_{i})$	1	3050 tc	AS_SED	MPREPS
OVA	1	300010	AS_SED	MPREPS
100	1	305010	AS_SED	MPREPS
114	1	305010	AS_SED	MPREPS
1126	- 1	BOSUTO	AS_SCD	MPREPS
TBA	1	) <b>( 19</b> 57)	AS_SED	MPREPS
144	- 1	00501C	AS_SED	MPREPS
11/A	1	305010	AS_SED	MPREPS
16.A	1	3050 CC	AS_SED	MPREP5
1.7A	1	305010	AS_SED	MPREPS
1896	ŀ	305010	AS_SED	MPREPS
156	1	SMEMIC	AS_SED	MPREPS
SHAZ	1	305010	AS_SED	MPREPS
RIA.	ı	0050 FC	AS_SED	MPREPS
MBM	- 1	3010	AS_SED	MPREPW
1990	1	3010	AS_SED	MPREPW
177M.	ł	3016	AS_SCD	MPREPW
1520	1	3010	AGLSED	MPREPW
27.05	ı	OWIN	ASISED	MPREPW
.2# <b>4</b>	1	200 (10)	AB_BCD	MPREPW
11.0	1	3010	AS, SED	MPREPW
$\sim \Delta$	ł	3010	ASLEED	MPREPW
$\ldots  _{\nabla}$	1	วดาก	$\Delta S_{\omega}$ SED	MPREPW
11.16	ł	3616	80,500	MPREPH



TIVIA
Thermo Analytical Inc.

CUSTODY TRANSFER ..... LAB WORK REQUEST

memor	naiyticai ind	n.	and bouton			c1	ient 5	25		Contact					
		ne	scerved by	, 17	14190	Co	ntoot M	Phil	اللهم	Date Du	e 17	2/27/90	<u> </u>		
TMA/Eberline		_ Da	ate Shipped	1 ! 4	14190	CO	urac c iv.	3.1 1	1=	Dave Du					
7021 Pan Ameri	can Hwy	- A:	ssigned to	<u> </u>	LI	Ph	one		<u> </u>	WO Numb	er				
Albuquerque, NI (505) 345-3461	M 87109	SAMI	PLE IDENTIF	PICATI	ON	•				ANALYSE:	S REQ	uested	/	or 2	•
Sample No.	Client ID	Descript	1on ¥	Mat.	Collected	loi	dainer								
IA	Aug 20	Sail	300 CPM	S	11-14-90			Merals	5		ĺ				
2A	22		BKG	5	11-14-90										
3A	23		BKG	S	11-14-90										
. 4A	25	/	RKG	5	1540										
5A	6		200 CPM	5	11-14-90 11-14-90 11-14-90 11-14-90 11-14-90 11-14-90			=I							
6A	10		80 CPM	5	1-14-90										
7A	il		300 CPM	5	11-14-90			$I_{-}$							
RA	wash aua 3. of Rus.		BKG	5	1650										
9A	ROAD TO B-V  OR ROAD TO  OR ROAD TO  AND A CONTROL  RADON CONTROL  RESTOR CONTROL  RESTOR CONTROL  ON TO THE CONTROL  ON TO TO THE CONTROL  ON TO TO THE CONTROL  ON TO TO TO THE CONTROL  ON TO TO TO THE CONTROL  ON TO TO TO THE CONTROL  ON TO TO THE CONTROL  ON T		BK6	5											
IQA	M. ROTO IS	ì	BKb	5	11-14-90 0830 11-15-90 1005 11-15-90 1125										
IIA	mini Pot	\	3KG	5	11-15-90			1							
12A	Radarcaitre	lgi.	BKG	S	11-15-90	_									
13A	Radon gordande	e	BKG	-5-	11-15-90										
14-A	5ta. 11		BKIT	5_	1210										
15A			BK4	ے	11-15-90										
16A			BKG	5	15-90										
170	STA 10		BKB	5	12.10 11-15-90 11-15-90 12-15-90 11-15-90 11-15-90						_				
			BKG	5	11-15-90										
MA			BKG	_ک	11-15-90 15-15 11-15-90 11-15-90 11-15-90										
, 20A		$\sim$	BKB	5	11-15-90			V							
Matrix:		,					cial inst	truct	lons	•	•	•	_	•	
S-soil	DL-drum li		S-drum sol	.1d	_	_									
W-water	B-bio samp	oles X	-other		*	KN	M4S								
Item/Reason	Relinguish	ed By	Received B	v	Date Ti	me	Item/Rea	son	Reli	nau1shed	By	Receive	d By	Dat	e
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# TIVIA Thermo Analytical Inc.

## CUSTODY TRANSFER RECORD/ LAB WORK REQUEST

	•	Re	ceived By_			C	lient		Conf	tact				
TMA/Eberline			te Shipped				ontact		Date	e Due				
7021 Pan Ameri	can Hwy	-	signed to				none			Number				-
Albuquerque, NI (505) 345-3461	M 87109	•	LE IDENTIF						ANAL	yses req	UESTED	2.0	f 2.	
Sample No.	Client ID	Descripti	on 👱	Mat.	Collec	ted Co	ntainer	1						(PORPO, Proc. )
21A	STA 40	عاد ا	800 CPM	S	1540	50		WETALS					-	
Wi	EFE	water	BK6	W	11-16-	90			1					
W Z	EJE		BKb	W	11-16-9 11-16-9 11-16-9 11-16-9 11-16-9 11-16-9	90								
wa	B-V TAPLAN		BKG	W	11-16-9	<u></u>								
w4	B-V Wall bridged Standard bridged published published wall		BKG	W	11-99:05	ρ								
W5	Stricter		BK6	W	U=16=3			-						
W6	TOUR		BKb	W	11-16-3	2		1						
W7-	Malling		BKb.	W	11-16-9	<u>b</u>		<u> </u>	<u> </u>					
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Matrix: S-soil W-water	DL-drum li B-bio samp		G-drum sol -other	ia			cial ins	itructi	ions:		•			
tem/Reason	Relinguish	ed By . I	Received B	У	Date	Time	Item/Re	ason I	Relinquis	hed By	Received	Ву	Date	T1m
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# APPENDIX C Laboratory Preliminary Results

505 761 5416 Jan 16.91 15:38 ALBUQUERQUE LABORATORY Ecology and Enrument 160 speak street #930 40 Ca. 94105 E2732 E500 B-V Linestock Well WI 11-16-90 Rath 3839.3m Rozes 025 11 200/4 20=0. 235 0.3 = 0.1 235 0.4 = 0. 11-16-90 Page 01 B-11 Linestockwell w2 0.Z±0.1 2708.3 2000 0±5 2710 U 23/4 0,500 U 235 0.0=0. U 238 0.0+0. OZ B-V Tap Weter. 3961.9 0.2=0.1 0 2 5 3960 U 233/4 2.120. 1235 ه پوهنوس 4 200 0.8±0.

RTP acrafied + feltered 11/16/90

INSERT UNITS

2- FAY 1-4-91 Need Ress (TO Et E

TIVIA Eberline
Thermo Analytical Inc.
2021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE NEW MEXICO 82100

Phy-4-90

Jane Kul

12/16/

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CUSTOMEN ECOLOGY & Embranens

ADDRESS

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PRELIMINARY DATE

ALEUQUERQUE LABORATORY

E2737

	1	154647		PASSES.		9868000	Herring	
	- modela mischi poleppi					ALIGNOT .		
772	B-V Well	ω4	18-16-90	Rate	3865.1.	G BRATTEL PRATTER	1	0.12
<u>. ح</u> ب الا	O . K . Fr Tr		1	D. 72	2000		1	0=
				11.254	3870			1.4
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~	Deviduro top Water	126	11-16-90	R 226	4054.1		1	0.3
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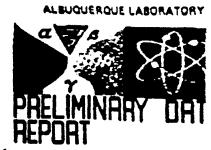
TIMA Eberline
Thermo Analytical Inc.
7021 PAN AMERICAN PREEWAY, N.E.
ALBUQUEROUE, NEW MEXICO 87100

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PAGE 2 OF 3

CURTOMER Ecology & Environment
ADDRESS
CITY



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#### **DEPARTMENT OF HEALTH & HUMAN SERVICES**

Dic Health Service
Health Services Administration

Navajo Area Indian Health Service P. O. Box G Window Rock, Arizona 86515

May 09, 1991

Rosita Loretta Baca Chapter Coordinator P.O. Box 127 Prewitt, New Mexico 87045

Dear Ms. Loretto:

Per request, on February 25, 1991, radiochemistry water quality samples were taken from the livestock windmill well number 16T521 next to the Head Start School in Haystack.

Analytical results of the samples are attached and are summarized below:

<u>Analysis</u>	<u>Results</u>	<u>Max Allowable</u>
Ra-226/228	0 pCi/L	5 pCi/L
G-Alpha	15.5 pCi/L	15 pCi/L

The Radium results are well below EPA drinking water standards, however, the Gamma-Alpha results are slightly above the standard. Additionally, the water from this well is not treated in any way for bacteria or other contaminants. While this water may be suitable for livestock, it is unsuitable for humans. Therefore, it is recommended that chapter members not use the water from this well for human consumption.

We have notified Water Resources in Crownpoint and requested they re-paint clearly the "LIVESTOCK USE ONLY" sign on the water storage tank.

Please communicate the contents of this letter to all chapter members. If you have any questions regarding this matter, please call Mr. Peter Fant or Thomas Hill at 505/786-5291, extension 403. Your cooperation is appreciated.

Respectfully,

Charles O. Dowell Director, OFHE

xc: CHR/Baca

Crownpoint WRD Fort Defiance WRD Gallup District TATE OF NEW MEXICO

HEALTH AND EN KUNMENT DEPARTMENT

### SCIENTIFIC LABORATORY DIVISION QUE OF 11

P.O. Box 4700

Albuquerque, NM 87196-4700

700 Camino de Salud, NE

[505]-841-2500

NE 4/13/31 HE

April 15, 1991

Request ID No. 012140

ANALYTICAL REPORT SLD Accession No. RC-91-0037

RADIOCHEMISTRY SECTION [505]-841-2574

Distribution

(__) User 81230

(E) Submitter 310

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To: Harry A. Doutt

U.S.PHS; Navajo Area IHS-OEH/ Sanitation Facilities Construction

P. O. Box 648

Ft. Defiance, AZ 86504

From: Radiochemistry Section

Scientific Laboratory Div. 700 Camino de Salud, NE

Albuquerque, NM 87106

LOCATION

Re: A water sample submitted to this laboratory on February 25, 1991

#### DEMOGRAPHIC DATA

At: 12:00 hrs. In/Near: McKinley County

ANALYTICAL RESULTS

Analysis	Value	Sigma	D. Lmt.	Units	Analyst
G-Alpha w/ Am-241 ref.	40.00	3.00	0.70	pCi/L	Maloy
G-Alpha w/ U-nat ref.	47.00	4.00	1.10	pCi/L	Maloy
G-Beta w/ Cs-137 ref.	13.60	2.30	1.30	pCi/L	Maloy
G-Beta w/ Sr/Y90 ref.	13.20	2.20	1.30	pCi/L	Maloy
UChem, Fluoro, uG/L	35.00	7.00	5.00	uG/L	Bitner
assuming U-nat conversion	24.50	4.90	3.50	pCi/L	(calculated)
Ra-226, SDWA Method	-0.01	0.04	0.03	pCi/L	Maloy

#### Notations & Comments:

Uncertainties, sigmas, are expressed as +- one standard deviation, i.e. one standard error.

Small negative or positive values which are less than two(2) standard deviations should be interpreted as: including 'zero'; as 'not detected'; as 'less than the detection limit (<D. Lmt.)' when reported; or 'less than twice the standard deviation'.

Reviewed By:

Loren A. Berge, Ph.D.

04/15/91

Supervisor, Radiochemistry Section

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# Uranium Resources of Northwestern New Mexico

By LOWELL S. HILPERT

GEOLOGICAL SURVEY PROFESSIONAL PAPER 603

Prepared on behalf of the U.S. Atomic Energy Commission

A description of the stratigraphic and structural relations of the various types of uranium deposits in one of the world's great uranium-producing regions



194 (table 3). Ores in limestone are second in importance, having yielded about 4 percent of the total; ores in carbonaceous shale and coal, and in igneous rocks, constitute less than 1 percent of the total.

The uranium: vanadium ratio of the ores generally is about the same regardless of the grade, type, or age of host rock. Where the average grades show marked differences from the general averages, the tonnage is small and the differences are probably not significant.

At the end of 1958, most of the uranium ores from northwestern New Mexico were being processed by six mills which had a total rated capacity of 11,075 tons per day 2. At the end of 1964, through a property merger and the closure of one mill, the following mills were operating; they had a collective rated capacity of 9.000-10,000 tons per day:

Company	Location			
Vanadium Corp. of America	Shiprock.			
Homestake-Sapin Partners	Grants.			
Kermac Nuclear Fuels Corp	Grants.			
The Anaconda Co	Bluewater.			

#### GEOLOGIC SETTING

The three physiographic units, or provinces, in northwestern New Mexico are marked by structural and lithologic as well as physiographic characteristics (fig. 1). The northern part of the area in the Colorado Plateaus province is a broad structural as well as topographic depression, the San Juan Basin. It is characterized by a sedimentary fill of marine and continental rocks that totals several thousand feet in thickness and ranges from Paleozoic to Quaternary in age. Locally around the margins of the basin there are intrusive igneous rocks of Tertiary and Quaternary ages. The southern part of the province, the Datil volcanic field, is characterized by an extensive covering of lavas and associated continental sedimentary rocks that totals several thousand feet in thickness. These rocks are mostly Tertiary and Quaternary in age and cover older marine and continental sedimentary rocks which are exposed along the east and north margins of the area.

The part of the area in the Southern Rocky Mountains province consists generally of mountain blocks that have Precambrian cores; these blocks are draped by marine and continental sedimentary rocks, mostly of late Paleozoic and Mesozoic ages, that are several thousand feet thick, and by valley fills and local volcanic piles of Tertiary and Quaternary ages that also are several thousand feet thick.

The part of the area in the Basin and Range province is characterized by northward-trending faultblock mountains and intervening basins. Along the western part of the province and extending northward into the Southern Rocky Mountains province is the Rio Grande trough, a structural depression. It is filled by several thousand feet of continental sedimentary and volcanic rocks of late Tertiary and Quaternary ages. East of the Rio Grande, the fault-block mountains are generally underlain by crystalline rocks of Precambrian age which are capped by eastward-dipping marine and continental sedimentary rocks of late Paleozoic and Mesozoic ages and by continental sedimentary rocks of Tertiary and Quaternary ages. These rocks total several thousand feet in thickness. At the north end of the province the early Tertiary and older rocks are intruded by laccolithic masses of early Tertiary age.

#### **STRATIGRAPHY**

The lithology, thickness, areal distribution, and stratigraphic relations of the uranium-bearing and as-

Table 3 .- Uranium ores produced from northwestern New Mexico, classified by age and type of host rock, 1950-64

Но	Tons of ore	Percent of	U3(); (weight	(wei	V _{2O₅} t ght percent)	CaCO ₁ ² (weight percent)			
Age	Туре	1 0113 01 010	tonnage	percent)	,,,,,		The state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the s		
Tertiary	Igneous rock	9, 285	0. 1	0. 14	0. 04	(68)	11. 3	(97)	
•	Sandstone		. 1	. 33	. 03	(6,877)	1. 2	(6, 995)	
Cretaceous	Sandstone	57, 791	. 3	. 23	. 11	(43, 920)	. 6	(40, 273)	
	Carbonaceous shale and	6, 497	. 1	. 20	. 03	(4, 438)	. 7	(2, 434)	
* .	coal.					. (0 004 101)		(0.570.000)	
Jurassic	Sandstone	22, 035, 186	95. 4	. 22	. 13	$^{3}(2,364,101)$	1. 2	(2, 578, 929)	
	Limestone	975, 497	4. 2	. 22	. 14	(444, 965)	80. 5	(413, 325)	
	Limestone and sandstone	4, 513	. 1	. 34	. 16	(999)	42. 2	(1,848)	
Permian	Sandstone	67	. 1	. 14	. 13	(67)	14.0	(59)	
	Limestone	1, 039	. 1	. 21	. 38	(803)	51. 7	(727)	
Pennsylvanian	Limestone	183	. î	. 12	. 10	(183)	11.7	4 (183)	
Total or weighted	average	23, 099, 094	100. 6	0. 22	5 0. 13	5 (2, 414, 965)	⁵ 1. 2	5 (2, 626, 256)	
	***	. ,							

² U.S. Atomic Energy Commission press release 222, Feb. 1, 1959, Grand Junction, Colo.

Numbers in parentheses are tons of ore assayed for V₁O₅.
 Numbers in parentheses are tons of ore assayed for CaCO₂.
 Excludes tonnage for Shiprock district, which for 24,027 tons averaged 2.56 per-

⁴ Probably silicified as well as sandy.
5 Only the ores in sandstone are reported.

(Harshbarger and others, 1957; Smith, 1954; Rapaport and others, 1952) and generally extend northeastward from Laguna into north-central New Mexico (D. D. Dickey, written commun., 1963). In most places the Entrada rests on the Wingate Sandstone, but at least in the southeastern part of the Laguna district it rests on the Chinle Formation (Kelly and Wood, 1946). Elsewhere in the Laguna district, rocks that have been called Wingate might belong in the Entrada. If they do, the Entrada rests on the Chinle throughout the district (Hilpert, 1963, p. 6-9).

The upper sandy member of the Entrada constitutes the thicker part of the formation and contains the known uranium deposits. It consists of reddish-orange to white fine-grained quartz sandstone and is marked by thick sets of large-scale crossbeds. It ranges in thickness from 80 to about 250 feet, and has a tendency to weather into bold rounded cliffs. The medial silty member, the lower unit in northwestern New Mexico, consists of red and gray siltstone and ranges in thickness from 10 to about 100 feet.

#### TODILTO LIMESTONE

The Todilto Limestone (Gregory, 1917, p. 55) rests on the Entrada Sandstone and has about the same outcrop pattern. Southward it pinches out along a line that is 10-20 miles south of U.S. Highway 66 (Rapapert and others, 1952). This line trends westward to a point south of Grants and then swings northwestward into Arizona west of Chuska Peak (pl. 1).

The Todilto Limestone consists of two units. The basal unit, which generally ranges in thickness from 10 to 30 feet, consists of thin-bedded gray fine-grained limestone and some thin interbeds of siltstone and is present everywhere the Todilto crops out. The upper unit, which ranges in thickness from 0 to 100 feet, consists of anhydrite and gypsum and crops out along the east side of the San Juan Basin and northeast of the Sandia Mountains and extends under the central part of the basin. (See pl. 3.) Some of the debris in the Todilto consists of volcanic ash (Weeks and Truesdell, 1958). In some places the beds are nearly black, and some fine black carbonaceous material is concentrated locally along bedding planes. Wherever the limestone is pulverized it emits a fetid odor, and this characteristic coupled with the dark color, has led many to speak of the limestone as "petroliferous." Whether or not the limestone contains hydrocarbons and is petroliferous, its content of organic carbon is low, for it only locally contains as much as 1 percent organic carbon and in general averages only a few tenths of 1 percent. The relations of the organic carbon

to the uranium deposits is discussed under "Distribution of Elements in the Todilto Limestone."

#### SUMMERVILLE FORMATION

The Summerville Formation (Gilluly and Reeside, 1928, p. 79-80) overlies the Todilto Limestone and has about the same distribution pattern as the Todilto in northwestern New Mexico (J.S. Wright, oral commun., 1958). The Summerville ranges in thickness from 50 to about 225 feet and averages about 150 feet. It consists of reddish-brown and gray fine-grained sandstone and siltstone, whose individual units range in thickness from a few inches to a few feet. South of Grants and south of Laguna, near its south margin, the Summerville contains a basal quartzite-pebble conglomerate (Silver, 1948, p. 78; Hilpert, 1963, p. 12). The bedding is mostly parallel and probably represents near-shore deposition in a shallow marine embayment.

#### BLUFF SANDSTONE

Overlying the Summerville Formation is the Bluff Sandstone of the San Rafael Group (Gregory, 1938, p. 58-59), which crops out along the west and south sides of the San Juan Basin (Harshbarger and others, 1957, p. 42-43; Freeman and Hilpert, 1956). The Bluff Sandstone is a pale-orange or buff fine- to medium-grained crossbedded sandstone which weathers into bold rounded cliffs similar to those of the Entrada Sandstone. The Bluff ranges in thickness from about 50 feet in western San Juan County to about 300 feet in McKinley and Valencia Counties. In southwestern McKinley County the Bluff grades into the stratigraphically more extensive Cow Springs Sandstone (Harshbarger and others, 1957, p. 48-51) which occupies the entire stratigraphic interval occupied elsewhere by the Todilto Limestone, Summerville Formation, Bluff Sandstone, and part of the overlying Morrison Formation. On plate 1 these units are mapped with Zuni Sandstone in McKinley and Valencia Counties.

#### MORRISON FORMATION

The Morrison Formation (Cross, 1894, p. 2; Emmons and others, 1896) is the most important host for uranium deposits in northwestern New Mexico. Its distribution is similar to the San Rafael Group, and it originally covered most of the mapped area (pl. 1) and extended into northeastern Arizona, eastern Utah, and southwestern Colorado (Craig and others, 1955, fig. 19, p. 129). The former southern extent of the Morrison in New Mexico is not known because the beds were removed by erosion prior to the deposition of the overlying Dakota Sandstone

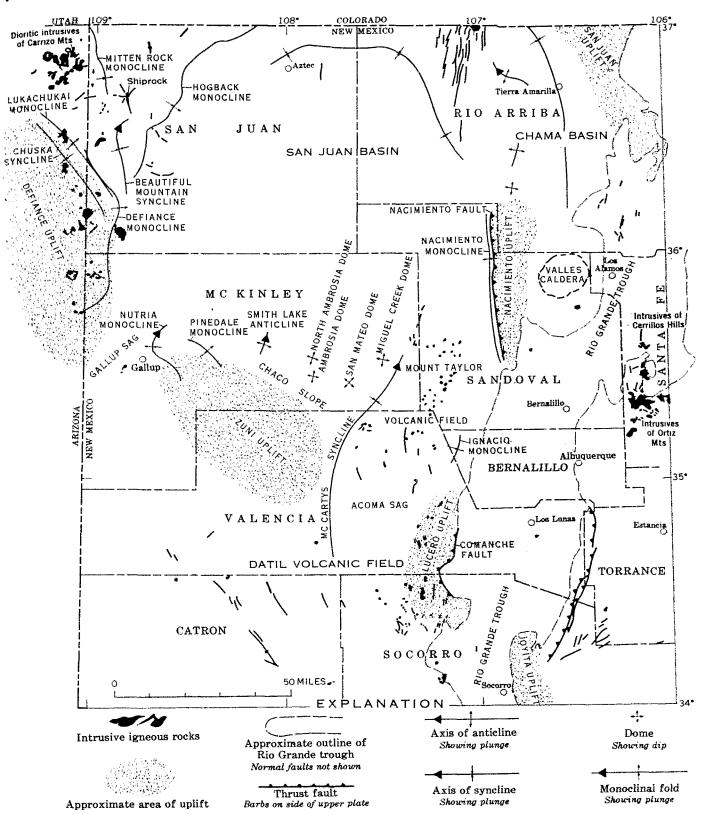


FIGURE 3.—Principal structural elements in northwestern New Mexico and adjoining areas. Modified from Kelley (1954; 1955, fig. 2); O'Sullivan and Beaumont (1957); Dane and Bachman (1957a); and O'Sullivan and Beikman (1963, sheet 2).

329-381 O-69-3

draped on their flanks with marine and continental beds of late Paleozoic and Mesozoic ages and some volcanic rocks of Tertiary and Quaternary ages. The rocks of the Rio Grande trough, as farther south, are composed of continental sediments and volcanic debris. The west part of the trough and the east flank of the Sierra Nacimiento are covered by the volcanic pile of the Jemez Mountains which are associated genetically with the Valles caldera.

The principal faults in northwestern New Mexico are concentrated mostly along the periphery of the Rio Grande trough, along the flanks of the ranges of the Southern Rocky Mountains province, and to a lesser extent in the east and northeast flanks of the Zuni uplift and south margin of the San Juan Basin. Most of the faults are normal and high angle and can be traced along the strike for distances of as much as several tens of miles. In the Colorado Plateaus province the faults rarely have a stratigraphic throw of more than a few hundred feet, but in the other provinces the throw on some faults is as much as several thousand feet.

Thrust faults are less common, but one occurs along the west margin of the Southern Rocky Mountains province, and several occur in the Basin and Range province. The most conspicuous thrust fault strikes northward for more than 50 miles along the west flank of the Sierra Nacimiento and the San Pedro Mountains. It dips steeply eastward and generally separates Precambrian crystalline rocks and pre-Triassic sedimentary rocks on the east from Permian and younger rocks on the west (Northrop and other, 1946). Other conspicuous thrusts occur on opposite sides of the Rio Grande trough. One skirts the east flank of Lucero Mesa for a distance of about 20 miles and, at different places along the strike, dips westward from low to high angle, and separates Precambrian and younger rocks on the west from Triassic and younger rocks on the east (Kelley and Wood, 1946). Other thrusts skirt the east flank of the Los Pinos and Manzano Mountains, generally extend along the strike for 10-15 miles, and dip steeply westward. They generally separate Precambrian rocks on the west from Paleozoic rocks on the east (Read and others, 1944; Wilpolt and others, 1946; Wilpolt and Wanek, 1951). The age relations and dating of the various structural features are discussed in the geologic history which follows.

#### **GEOLOGIC HISTORY**

The following résumé of the geologic history of northwestern New Mexico is intended to provide a background for understanding the relations of the

uranium deposits to the host rocks and to the s mentary, tectonic, and igneous structural featu Where pertinent, more detail is given under descriptions of the mining districts and the au containing the deposits.

The record of the Precambrian Era is obscure, but has been long and complex and has been marked deformation, metamorphism, and intrusion by grain and associated rocks. Associated with some of granite in the eastern part of Rio Arriba Couwere injections of uraniferous pegmatite and ura erous fluorite and quartz veins.

The Precambrian rocks subsequently were eroded a peneplain; after this erosion period, the area probably a stable shelf for most of the Paleozoic I (Kelley, 1955, p. 75). Some marine waters encroad on the northern part of the area at various times, purably during the Cambrian and again during Devonian and Mississippian (Bass, 1944; Strol 1958; Baltz and Read, 1960), but the rocks that we deposited are not exposed at the surface and the received for northwestern New Mexico has been determined from minimal well data and by projection for adjacent areas. The rocks that were deposited during this time interval comprise unnamed Cambrian clastics, the Elbert Formation, the Ouray Limest and the Leadville Limestone.

During Mississippian time, marine waters encroached on the eastern part of the area and limestone and associated clastics of the Caloso Fortion of Kelley and Silver (1952), Kelly Limest and Arroyo Penasco Formation were deposited.

During late Paleozoic time, two positive struct features began to form; these have persisted intertently, with modifications, to the present and had considerable influence on subsequent geol events. One of the features, the antecedent of the Juan uplift and generally known as the San I Uncompangre uplift, was an elongate arch wi began to form in Early Pennsylvanian time (W. Mallory, oral commun., 1963) and which exter from the northeastern part of the area northwesty into Colorado. The other feature, the anteceden the Zuni and Defiance uplifts, emerged as a br upwarp about the same time and extended from a the present position of the Zuni Mountains no westward into Arizona. Between these two uplif trough formed in Early Pennsylvanian time that tended northward through the central part of area and received marine and continental sediment Pennsylvanian and Permian ages. These sedimen deposits include, in the southern part of the area, the Sandia Formation, Madera Limestone, Abo and Yeso Formations, Glorieta Sandstone, and San Andres Limestone, and in the northern part of the area, the Molas, Hermosa, Rico, and Cutler Formations. Locally the sedimentation of the upper part of the Madera Limestone and the overlying Abo and Yeso Formations was affected by a positive structural feature that formed in the vicinity of the Joyita Hills (Wilpolt and others, 1946).

Another positive structural feature also was elevated in Pennsylvanian time near the center of the trough and extended northward through the approximate position of the present Nacimiento and San Pedro Mountains area. This structure was antecedent to the Nacimiento uplift, and its position is marked by nondeposition of the upper part of the Madera Limestone and the interbedding of clastic materials with the limestone in the periphery of the uplift (Wood and others, 1946).

The antecedent Zuni and Nacimiento uplifts became buried by Early Permian time and, during the latter part of the Permian and Early Triassic, the Early Permian and older rocks were deformed and beveled. About Middle Triassic time, after the Moenkopi Formation was deposited, the San Juan highlands and other highlands to the southeast of the area were upwarped. Upwarping was accompanied by some volcanic activity elsewhere to the south and southeast of the mapped area (Allen, 1930; Stewart and others, 1959, p. 566).

Northwestern New Mexico at this time was part of a broad plain that sloped westward into Arizona and northwestward into Utah and Colorado. This plain received clastic debris from the highlands to the southeast and northeast and received volcanic debris from the south and southeast; the clastic and volcanic debris formed deposits that now constitute the Chinle Formation and part of the Dockum Formation. The Shinarump Member and Poleo Sandstone Lentil of the Chinle probably had a source in highlands to the south (McKee and others, 1959, p. 22). The northern part of the Agua Zarca Sandstone Member, as recognized by Wood, Northrop, and Cowan (1946), was derived from highlands to the north, and the southern part of the member from highlands to the south (F. G. Poole, written commun., 1957).

Relatively stable conditions existed during Late Triassic and Early Jurassic time and the highland areas were reduced to low relief. On the old flood plain the Wingate and Entrada Sandstones accumulated principally from wind action.

In Late Jurassic time the Zuni uplift was rejuvenated and a broad shallow basin and flood plain was formed to the north. This plain extended into northeastern Arizona, southeastern Utah, and southwestern Colorado. In the basin the Entrada Sandstone, Todilto Limestone, Summerville Formation, Bluff Sandstone (mapped with the Zuni Sandstone on pl. 1), and the Morrison Formation were deposited. The basin was above sea level, except for a time that a shallow embayment opened to the west and permitted entrance of marine waters in which the Summerville Formation and possibly the Todilto Limestone were deposited (Harshbarger and others, 1957; Anderson and Kirkland, 1960). Some volcanic activity, possibly to the southwest of the basin of deposition, accompanied the Morrison deposition.

At the time of deposition of the Jurassic rocks the junction of the uplift, or highland, and the basin areas was within a general zone now marked approximately by the southern outcrop of the Jurassic rocks. This junction is indicated by the depositional margin of the Todilto Limestone (Rapaport and others, 1952), local conglomerate facies of the Summerville on its south margin, general coarsening of the Morrison southward (Craig and others, 1955), and local pinching of the Morrison southward against the Bluff Sandstone (Thaden and Santos, 1957).

While the Jurassic sediments were being deposited, the basin receiving them slowly and differentially subsided as the highland area was rising. These movements caused flexing or broad folding. The flexures occur along the south margin of the San Juan Basin near the probable margin of the old Jurassic basin (Hilpert and Moench, 1960). They probably were concentrated along the marginal zone of the old basin because this would be the zone of maximum differential movement between the basin and the highland area. As the flexures formed, they probably partly controlled the course of the streams that deposited the Morrison sands and influenced the accumulation of the sand units because the foreset beds in the sandstone units show a dominant eastward dip and the sandstone units show an eastward elongation (Rapaport and others, 1952, p. 31-32; Mathewson, 1953; Sharp, 1955, p. 8, 11; Hilpert and Moench, 1960).

The flexing may also have formed local basins in which units like the Jackpile sandstone, of local usage, accumulated (Moench and Schlee, 1959). Such sandstone units contain the largest uranium deposits known in northwestern New Mexico. The flexing may also

have helped initiate the development of the Ambrosia dome and other similar structural features in the general vicinity. Moreover, intraformational folds in the Todilto Limestone and pipelike collapse features in sandstones of the Summerville, Bluff, and Morrison Formations probably were caused by or related to this flexing.

In Late Jurassic or Early Cretaceous time the southern highland area and basin margin were tilted upward and beveled, and all formations down to the Abo Formation were progressively cut out southward. Gradual subsidence followed the beveling, and a wide seaway then encroached on the entire area of northwestern New Mexico and adjoining regions. The sea spread gradually from the southeast and the northeast and left a sequence of near-shore continental and shallow marine sediments. These sediments range from the Dakota Sandstone at the base to the Pictured Cliffs Sandstone and total several thousand feet in thickness. Deposition occurred during several transgressions and regressions of the shoreline (Sears and others, 1941); these fluctuations were accompanied by settling of the basin and differential uplift of a rather extensive highland to the southwest which contributed the sediments.

In Late Cretaceous time, as the seas gradually withdrew, the continental Fruitland Formation and Kirtland Shale were deposited. Probably late in this interval, tectonic activity, accompanied by volcanism, in the San Juan Mountains area marked the emergence of the San Juan uplift (Hayes and Zapp, 1955). About the same time or shortly thereafter, the Defiance, Zuni, Lucero, and Nacimiento uplifts emerged, which caused the initial shaping of the San Juan basin; the filling of the basin then progressed by deposition of the continental beds of the Ojo Alamo Sandstone, Animas, Nacimiento, and San Jose Formations from debris shed by the uplifts. A pulselike rise of the uplifts is indicated by the beveling of the older formations by the younger around the basin margins (Hunt, 1956, p. 23-24).

The Late Cretaceous and early Tertiary tectonic events, generally referred to as the Laramide orogeny, are important in helping establish the ages of emplacement of many of the uranium deposits. Structural features that formed during this interval are the monoclinal folds on the basin sides of the uplifts that are marginal to the San Juan Basin, the depressions, or sags, between the adjacent uplifts, and the faults related to the development of these features. These features probably formed in accompaniment with the marked rise of the uplifts that flank the basin. This

interval is dated by the Nacimiento Formation of Paleocene age which was deposited during initial deepening of the basin. This deepening was largely concluded by the time of deposition of the San Jos Formation of early Eocene age which lies across the beveled beds of the Nacimiento Formation.

Structural features related to this age of tectonist are the Defiance, Nutria, and other similar monocline folds, the Ácoma and Zuni sags, and the McCarty syncline and the faults, fractures, and related fold along the syncline's western flank.

Thrust faults probably formed during this tim (Wood and others, 1946; Kelley and Wood, 1946; Wi polt and Wanek, 1951). Some normal faults may als have formed as early as the thrusts, but the normal faults generally are younger because they displace the thrusts (Kelley and Wood, 1946; Wilpolt and Wanel 1951) and generally range in age from early Tertian to Quaternary.

After the San Jose Formation was deposited, tiltin of the San Juan Basin northward reversed the di direction of the San Jose (Hunt, 1956, p. 25, 57). Som folding or faulting may have accompanied this tiltin and perhaps the McCartys syncline and associate folds and fractures evolved at this time (Hunt, 1938 p. 75), and the Ambrosia dome and other similar structural features were accentuated. It seems more reason able, however, to relate all these structural events with the preceding rise of the uplifts rather than tie them to simple tilting. The tilting and related events occurred in the post-early Eocene pre-late Miocene time interval because they postdate the San Jose Formatio and precede the faulting of the Santa Fe Group alon the Rio Grande trough.

In late early Tertiary time, probably during the Oligocene, volcanic activity began in the east-central part of the area and was followed in late Tertiary and Quaternary time by intermittent but widespread volcanic activity throughout much of northwestern New Mexico. The early activity left the laccolithic intrusives and associated volcanic rocks of the Ortiz Mountains and Cerrillos Hills and the dioritic intrusives of the Carrizo Mountains.

The late Tertiary and Quaternary activity left the extensive Datil-Mount Taylor volcanic field, the intrusive bodies, flows, pyroclastic rocks, and outwash debrialong the Rio Grande trough, and the dikes, sillenecks, and flows around the periphery of the Sa Juan Basin.

The Espinaso Volcanics probably were deposite

during the Oligocene, about the same time that the intrusive rocks of the Ortiz Mountains and Cerrillos Hills were emplaced (Stearns, 1943, p. 309; Disbrow and Stoll, 1957, p. 10-12, 33-34). These events were probably closely followed by emplacement of the basemetal deposits in the Los Cerrillos district (Lindgren and others, 1910, p. 167; Disbrow and Stoll, 1957, p. 46). Possibly about the same time, and somewhat later, the Datil Formation and related intrusive rocks were emplaced (Winchester, 1920, p. 9; Wilpolt and others, 1946). Late in this episode or soon thereafter, the baseand precious-metal vein and replacement deposits of the several mining districts in Socorro County were formed (Lindgren and others, 1910, p. 255; Loughlin and Koschmann, 1942, p. 56).

The dioritic and partly laccolithic intrusives of the Carrizo Mountains intrude the Mancos Shale, so are certainly Late Cretaceous or younger. More specifically their age is based indirectly on ages determined for similar intrusives elsewhere in the Colorado Plateau and adjacent areas. The oldest age for such rocks was considered to be Late Cretaceous for some of the intrusives in the La Plata Mountains of southwestern Colorado. Shoemaker (1956, p. 162) based this age on the correlation of diorite porphyry debris in the McDermott Member of the Animas Formation, assumed to have been derived from the La Platas. Other dates are younger and firmer. On geomorphic evidence, Hunt, Averitt, and Miller (1953, p. 212) inferred the Henry Mountains intrusives of south-central Utah to be middle Tertiary in age. The laccoliths of the West Elk Mountains in west-central Colorado are Eocene in age or younger because they intrude the Wasatch Formation (Godwin and Gaskill, 1964). More recently, isotopic age dates indicate that the La Sal Mountains laccoliths in southeastern Utah are late Oligocene to Miocene in age (Stern and others, 1965). The laccolithic intrusives of the Ortiz and Cerrillos Hills, which lie immediately southeast of the Colorado Plateau (fig. 3), also fit this general age pattern. They intrude the Galisteo Formation of late Eocene age (Stearns, 1943, p. 309) and are considered to be Oligocene in age (Disbrow and Stoll, 1957, p. 10-12, 33). It appears by analogy, therefore, that the dioritic, laccolithic, and related rocks of the Carrizo Mountains are most likely early to middle Tertiary in age, but could possibly be as old as Late Cretaceous.

In late Tertiary time, probably middle or late Miocene, widespread differential movements were initiated that were marked by uplift, some warping, and normal faulting, and these continued intermittently until at least the end of Tertiary time. The displacements defined the structural boundaries between the Basin and Range, Colorado Plateaus, and Southern Rocky Mountains provinces. During this time volcanic activity continued, and from the adjoining uplifts and volcanic centers the Rio Grande trough and adjoining areas received several thousand feet of alluvial and volcanic debris, including the materials in the Popotosa Formation and the Santa Fe Group.

#### URANIUM DEPOSITS

A uranium deposit as defined for this report is an occurrence that either has a content of 0.02 percent or more U₃O₈ by analysis or contains an identifiable uranium-bearing mineral. Such deposits occur in about 30 formational units, in seven principal lithologic types of host rocks, and in rocks of seven geologic periods. The host rocks and their ages are classified by symbols in plate 1 and, by number, the symbols show the deposits of mine rank. About 500 deposits or groups of deposits are represented, and the name, location, and a brief description of each is given in table 4. The information is summary and, between different deposits, is somewhat variable because of diverse source data and some company restrictions on publication of data on deposits, particularly subsurface data. Reference is made to the published literature for details on the more important deposits.

For descriptive purposes the uranium deposits are broadly classified as peneconcordant and vein types. By far the larger, more productive, and more abundant are the peneconcordant deposits. (Finch, 1959) which occur in sedimentary rocks and are generally concordant with the bedding, but in detail cut across it. The discordance indicates that the deposits were formed after the sediments accumulated. They differ from vein deposits in that fractures and faults have had only a subordinate or indirect influence in controlling them. The deposits occur mostly in sandstone and have been referred to as carnotite-, sandstone-, and plateau-type deposits; they also occur in limestone and in scattered localities in carbonaceous shale and coal. Vein deposits consist of fracture fillings, stockworks, mineralized breccia, and pegmatite occurrences. They occur in sedimentary, igneous, and metamorphic rocks and differ from peneconcordant deposits in their tendency to be controlled principally by fractures and in their general discordance with the bedding of the sedimentary rocks.

			COLORADO PLATEAUS PRO	VINCE	SOUTHERN ROCKY MOENTAINS A. AND THE CHAMA BASIN, COL	NO BASIN AND RAYOR PROVINCES
	PERIOD	EPOCH	SAN JUAN BASIN (EXCLUDING THE CRAMA BASIN)	DATIL SECTION	AREA SOUTH OF ALBUQUERQUE	
q	uateruar <del>y</del>	Recent and Pleistocene	Unnamed gravels and alluvium	Unnamed gravels and alluvium	Unnamed gravels and alluvium	Unnamed gravels and alluvium, Tuerto Gravel of Stearms (1963), and Puye Conglomerate
		Pliocena	Chuska Sandstone (700-900) and unnamed fluvial and lacustrine beds	•	Santa Fe Group (0- +5,000)	Santa Fe Group (010,000); includes the Ancha, Abiquiu, and Tesuque Formations,
		Miocene		) Datil Formation (0-2,000)	Popotosa Pormation -3,000-5,000)  Oatil Pormation (0-2,000)  Unnamed volcane flows and tuffs	volcanic flows and tuffs in upper part
	Tertiary	Oligocene				Espinase Volcanics 5 of Steams (1943) 5 of Steams (1943) 6 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (1943) 7 of Steams (
	~ <u>`</u>	Eocen <del>e</del>	dan Jose Formation (0-3,000)	Baca Formation (0-1,500)	Baca Formation (30-1,000)	Valuateo Permation
		Paleocene	Nacimiento Formation Animas Formation  (504-1,000) (509-3,000)			
(	retaceous	Late Cretaceous	Ojo Alamo Sandatone O-1001  Kirtland Shale (0-1,200)  Kirtland Shale (0-1,200)  Fruitiand Formation (0-500)  Pietured Cliffs Sandatone (70-100)  Lewis Shale (0-2,000)  Cliff House Sandatone (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,000) (100-1,0	Point Lookout Sandstone Toronation (2780)  Gallup Sandstone (±400)  Mancos Shale (78-400)	Mesaverde Genop undivided (0-700)  Mancon Shale (0-200)	Mesaverde Group undivided (500-1,000)
		Early(?) Cretaceous	Dakota Sandstone (0-200)	Dakota Sandstone (0-100)	Dakota Sandatone (+100)	Dakota Sandstone (8-200)
	Jurassic	Late Juramany	Brushy Bains Member (0-600); includes			Bummervilet ) Formation (-0.20)  Summervilet ) Formation (-0.20)
********		Middle and Early Jurassic	Winds & Section 1985	Wingate Sandstone (0-300);		Unnamed siltatone
	Triassic	Late Triassic	Wingste Sandstone (0-45), western and southern sides (0-10), western	orthern part    Open   Partified   Porest	<del></del>	Poleo Sandstone Lentil - 34-1501  Salitrai She Tongue (She 125)  Agrua Zarea Sandstone
	man, and a second	Middler?) and Earty Triassic	Moenkopi : Formation to-2001; southwestern part	Shinarump() Membe		Mamber (50-100)
	Permian	4.	De Coelly San Andres Limestone (1912): southern part (1914): south	(Septieca - sarpiacone ( - 200)	Bernal Formation (0-00): east of Rio Grands San Andres Limeatone (00-40): Glorieta Sandatone (25-40): Yeso Formation (600-1,00) Abo Formation (500-90): Bursum Formation (500-90): (3-250):	Cutter San Andres Immediate Survey So. Gloriesta Sandston (U-So.) Gloriesta Sandston (U-So.) Teac Formation (So.) Formation (200-700), south of latitude (Sr. N.)
route	Pennayi- vanian		in horth western ban Juan County  Madera Limestone, local  Hermosa Pormation 1,000-1,500; sub- sucface enty in San Juan County	s; / -1,700)	Magdalena (106-1,500)	Mondains Sard situation  Mondains Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control of Service Control o
artxaniferous	 		Molas Formation (60-175); subsurface only in northwestern San Juan County	£4001	(100-350)	in southern Herra Nacimiento
	Missis- sippian		Leadville Limestone (0-225); substarface only in northern San Juan County (Parsy Limestone and Elbert Formation (0-600).	Relly Limestone (0-75)	Kelly Limestone (0-75)  Caloso Formation of Kelley and Silver (1952) (0-30)	Arroyo Penasco Formation (0-150)
	Devonian	Late Devonian Middle	subsurface only in northwestern San Juan County			

Tertiary sandstone (O)

1 Charley 2 (Jeter)
2. Hook Ranch (Jaraiosa)
3. Red Basin I

Cretaceous sandstone(©)

F Becenti
2 Christian 16 (U)
3. Diamond 2 (Largo 2)

Junior Midnight 2

Section 5 (Westvaco) Silver Spur I Silver Spur 5

8. Silver Spur a 9. Small Stake

Cretaceous shale ( >

1 Butler Bros. 1 2 Hogback 3 3. Hogback 4 4. Section 3 (Santa Fe Christ)

Jurassic sandstone ( • )

1 Alongo 2 Alta 3 Am Lee (Section 28) 4 BB (Lewis Barton)* 5 BBB (Barton and Begay)*

Beacon Hill Begay t and 2 Black Jack 1 Black Jack 2

Blue Peak (Garcia I) []. Bob Cat (Section 34)

12. Bucky (Jeep 6)
13. CD and S (Section 35)
14. Canyon View*
15. Carl Yazzie (

15. Carl Yazzie (
16. Carrizo 1º
17. Castle T'sosie
18. Chaves (Cañoncito)
19. Chill Wills
20. Church Rock+

21. Cliffside (Section 36)
22. Collins
23. Cottonwood Button

Dennet Nezz Dennet Nezz 2

Dennet Nezz 3

Dog Incline (Dog group, East Malpais)

28. 29. 30.

Dysart 1 Dysart 2 Enos Johnson

Enos Johnson I

Enos Johnson 2 Enos Johnson 3 (South Peak)

31. Enos Jo 32. Enos Jo 33. Enos Jo 34. Evelyn 35. Foutz I

36. Foutz 2 37. Foutz 3 YJ (Yellow Jacket) 38. Francis 39. Hogan 40. H. B. Roy 2

41. Horace Ben i

42. Isabella 43. Jackpile 44. Joe Ben I 45. Joe Ben I

46. John Joe 1 47. Junction 48. Kee Tohe 49. King 2 50. King 6 (Troy Rose)

51. King Tutt 52. King Tutt 1 53. King Tutt 1 53. King Tutt Point* 54. Lone Star (Plot 9) 55. Lookout Point

56. M-6 57. Malpais 58. Marquez 59. Mary i 50. Mesa Top 7 (Moe,

50, Mesa 100 / Moe,
Davemport Inchine)
61 Mesa Top 18 (Holly)
62. Nelson Point
63. Paguate
64. Pat (Dakota)
65 Plot 7 (Lower Oak Springs)*

65. Poison Canyon

67. Rattlesnake 6*
68. Red Rocks*
69. Red Wash Point*
70. Rocky Flats

79. Rocky Flats 2
71. Rocky Flats 2
72. Rocky mine 2*
73. Saft Canyon
74. Sam Point*
75. Sandstone (Section 34)

76. Sandy 77. Section 8 (Centennial)

78. Section 10 79. Section 15 80. Section 17

80, Section 21 (Dorus)
82 Section 22 (Dorus)
83 Section 23
84 Section 24
85, Section 25
86, Section 25 (Kermae-United)

Section 30 (Kermae-Pacific) Section 30 (San Mateo)

89. Section 32 90. Sections 32-33 (West Ranch)

91, Section 33 (Branson) 92, Section 36 (United Western)

93 Shadyside 94 Shadyside 2 95. Silver Bit 7

96. Silver Bit 15 97. Silver Bit 18

98. Taify 99 Tent 100. Westwater I

101. Windwhin

Jurassie limestone ( A)

2 Barbara J 1 (Barbara J claims 8, 9, 13) 2 Barbara J 3 (Barbara J claims 22 and 23)

3 Billy The Kid (Red Top 1) 4 Black Hawk-Bunney 5 Cedar I (Section 20)

5 Cenar I (Section 20)
6 Christmas Day
7 Crackpot
8 Dakeo I (Barbara J 2)
9 Double Jerry (Farris I, Vallejo)
10 F-33 (Section 33)

10. F-33 (Section 35)
12. Falt Top 4-Vilatie Hyde
13. Gay Eagle-Red Bluff 8 and 10
14. Glover
15. Hanosh (Section 25)

16, Haystack (Haystack Butter/Section 19) 17. Haystack 2

18 La Jara 19. Last Chance 20. Lawrence Elkins

2) Lone Pine 3 22. Manoi (Section 30)

23. Paisano 24. Red Bluff 3 25. Red Bluff 5

25. Red Bluff 7 27. Red Bluff 9 28. Red Point Lode 29. Rimrock

29 Rimrock 30. Section 9

30. Section 13 (Bibo)
31. Section 18 (Bibo)
32. Section 18
33. Section 18
34. Section 19
35. Section 19 (Greer, Warren, and McCormack)

36. Section 19 (Maddox and Teagues 37. Section 21 38. Section 23 39. Section 24 40. Section 25

41. Section 31 42. Section 32

42. Section 32 43. Section 33 (Charlotte)

44, Section 36 45, T 2

46. T 10 47. Tom 13 48. Tom Elkins

49. UDC 5 50. Wasson (Box Canyon)

51. Whitecap 52. Zia Permian sandstone ( 6)

1 Hillfoot 1 2 Red Bird 3 Red Head 2

Permisu limestone ( *)

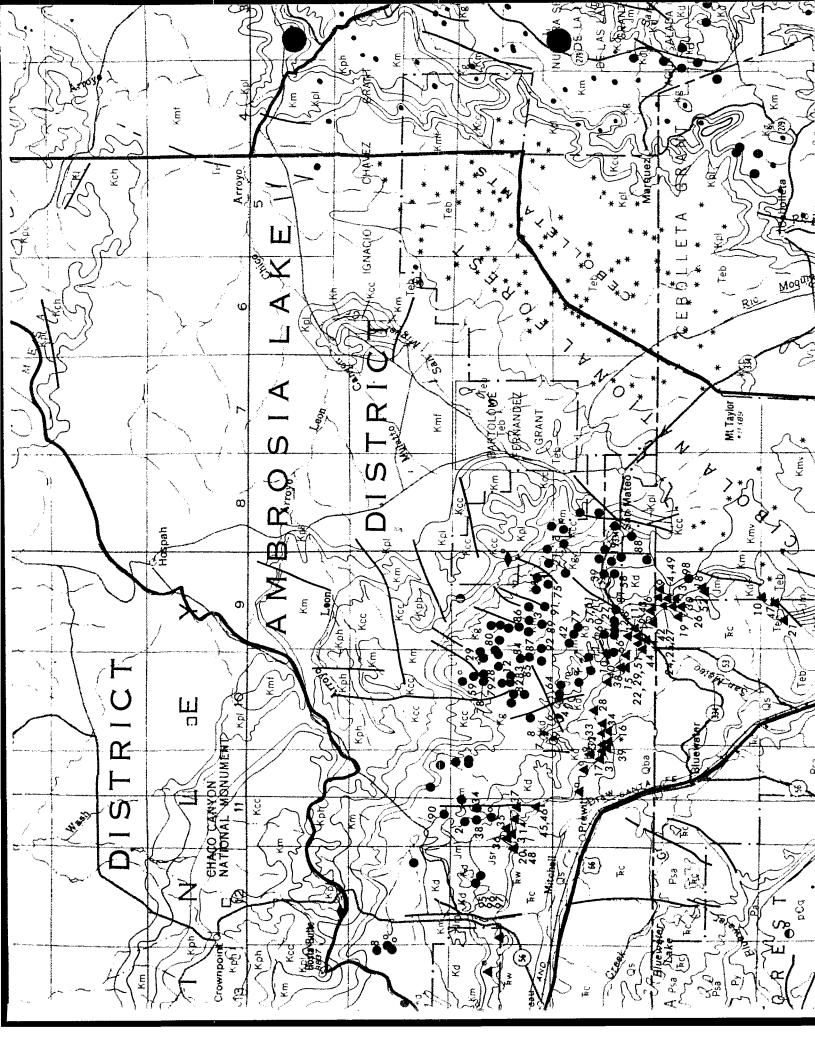
1. Lucky Don (Bonanza 1) 2. Little Davie

Pennsylvanian limestone ( 4)

1 Agua Torres 2 Marie

'in Shiprock district but location uncertain and other not pintled

JURASSIC



Manabah Yangeyer Si Report

UTM

coordinates for centroid easting = 777975 meters northing = 3915441 mete

search distance from centroid

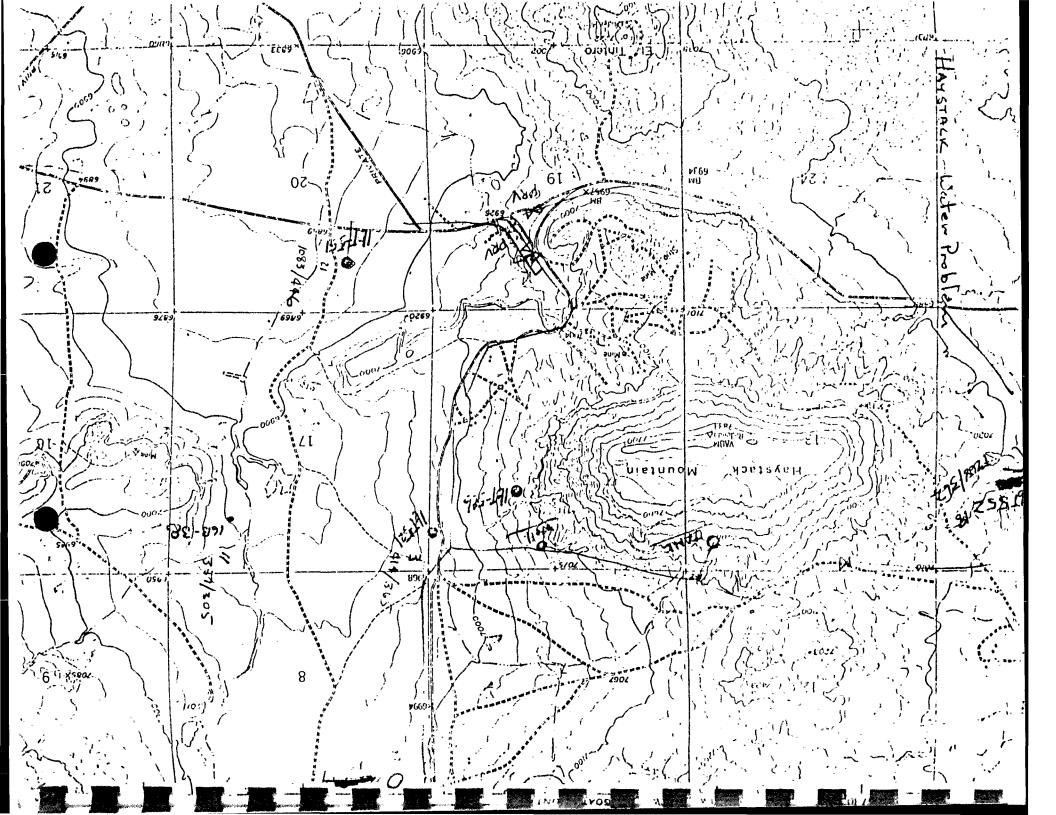
6500 meters east 6500 meters north

Ţ

6500 meters west 6500 meters south

window coordinates > minimum east minimum north maximum east maximum north 771475 3908941 784475 3921941

WELLNO	EAST	NORTH	DRILLED	DEPTH	SWL AQUIFER	OPERATOR
00-3289 00-3332 00-3341 168-38	780150 773644	3909728 3909728 3910762 3919037	// 1/ 1/57 11/ 5/57 5/12/36	351. 0 725. 0 200. 0 357. 0	64.0 231CHNL 243.7 313SADG 60.4 231CHNL 331.0 221SMVR	BERRYHILL BERRYHILL GIBBS TRIBE O&M
16T-521 16T-522 16T-551 16T-552 16T-586	782794 779489 774942	3915615 3915538	11/13/63 0/ 0/ 0 9/17/69 10/ 9/69 6/18/76	414. 0 270. 0 1083. 0 1268. 0 2400. 0	365. 0 221ENRD 0. 0 417. 0 231SNSL 362. 0 231CHNL 47. 0	TRIBE O&M TRIBE O&M TRIBE O&M TRIBE O&M TRIBE O&M



#### TRIBAL WELL RECORD LOCATION FILE

LOCATION FILE
ENTERED OCT 13 1986
TRIBAL WELL NO [/]6]7]-]5]2]/] ] ] ] PWSID [] ] ] ] ]
WELL NAME/OTHER NO []]]]]]]]]
WELL TYPE WELL STATUS WELL USE (MARK ONE ONLY) (MARK ONE ONLY)
( ) WW WATER WELL ( ) ACT ACTIVE ( ) DOM DOMESTIC ( ) WA ARTESIAN WELL ( ) INA INACTIVE ( ) AGR AGRICULT. ( ) WS SPRING ( ) ABA ABANDONED ( ) LIVESTOCK ( ) OW OBSERVATION WELL ( ) IND INDUSTRIAL ( ) GS GAS WELL MINING ( ) OP OIL PRODUCTION ( ) REC RECREATION ( ) MW MINERAL WELL ( ) OTH OTHER
QUAD NO [/]/]9] MILES WEST [/]0].]5]0] MILES SOUTH [/]0].]0]0]
NE SE SW NW NE SE SW NW NE SE SW NW [/]8] [T]/]3].]OW [R]/]O].]OW 10 acre 40 acre 160 acre SECT. TOWNSHIP RANGE
APPROXIMATE LOCATION [6] MILLES JEJAS T 1018 JPREMITT ]
[]]]]]]] LATITUDE[3]\$]2]1]2]6] LONGITUDE[/]0]7]5]6]/]0]
UTM COORDINATES: X(east)[]]]] Y(north)[]]]]] ZONE[]]
OPERATOR [7] R] / B R J O R M J USGS WATERSHED CODE [] ] ] ] ] ] ]
STATE: ( )AZ ARIZONA ( )NM NEW MEXICO ( )UT UTAH ( )CO COLORADO
COUNTY: ( )AP APACHE ( )MK MCKINLEY ( )SJ SAN JUAN ( )MT MONTEZUMA ( )NA NAVAJO ( )VL VALENCIA ( )KA KANE ( )LP LA PLATA ( )CO COCNINO ( )BL BERNALLILLO ( )SD SANDOVAL
( )SO SOCORRO GRAZING DISTRICT [/]6] ( )RA RIO ARRIBA ( )SA SAN JUAN
CHAPTER NAME RACA CHAPTER CODE [8]A]C]A]
LOCATION DATA SOURCE: [TRI/RE], BI-JSTOME RIT-G ] ] ] ] ]
LOCATION FILE COMPLETED BY: Masuel U. Zaman DATE 1019 11986
FIELD CHECKED BY: []]]]]]]]]] DATE _/_/_
rev:840425 form:well record loc

TRIBAL WELL RECORD HYDROLOGY FILE

ENTERED OCT 13 186 WELL NO [/]6]7]-]5]2]/] ] ] USGS AQUIFER CODE [2]2]/] [E]M[A]D] THICKNESS [ ] ] FT NOMINAL YIELD [ ] ] GPM YIELD MEASURED _/_/ ( )BAILER ( )PUMP TEST @ [ ] ] 3]GPM FOR [ ] 3]. ]O]HOURS DATE 1/13/1963 DRAWDOWN [ ] ] ]4]4]FT OBSERVATION WELL DATA AVAILABLE ()YES (2)NO HORIZ CONDUC. [VITY[]]]]]]]TT/DAY SPECIFIC CAPACITY[].]] GPM/FT VERT. CONDUCTIVITY[]]]]]] FT/DAY STORAGE COEF [.] ] ] ] ] COEF OF TRANSMISSIVITY [ ] ] ] ] FT2/DAY INDICATE ADDITIONAL PUMPING TEST DATA AVAILABLE AS HARD COPY: ( )Y ( )N MULTIPLE RATE DRAWDOWN PUMPING TEST ( )Y ( )N SINGLE RATE DRAWDOWN PUMPING TEST ( )Y ( )N MULTIPLE RATE DRAWDOWN/RECOVERY TEST ( )Y ( )N RECOVERY TEST LOGS AVAILABLE: (VDL DRILLER'S LOG ( )EL ELECTRIC LOG [7]8]/]8]2]]]]]]]]] HYDROLOGY DATA SOURCE: HYDROLOGY FILE COMPLETED BY: M. 2. DATE tol 9 /1986 ENTERED OF 17 SETATIC WATER LEVEL FILE DEPTH TO SWL 365 FT DATE ///3/1963 DEPTH TO SWL_____FT DATE / / DEPTH TO SWL ____ FT DATE / / DEPTH TO SWL ____ FT DATE / / DEPTH TO SWL ____ FT DATE / / DEPTH TO SWL ___ FT DATE / / DEPTH TO SWL ___ FT DATE / / DEPTH TO SWL ___ FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / rev:840427 form: well record hyd

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TRIBAL WELL RECORD STRUCTURE FILE	Jur.
WELL NO [/6]7]-[5]2]/] STARTED 10 15 1963 COMPLE	ERED OCT 1 3 1986
ELEVATION 17050 FT DEPTH 11414 FT DEPTH MEASU	RED N 1/3 1/963
DEPTH IS (MEASURED () ESTIMATED () REPORTED WELL DIA.	8.00 IN
1 CASING DIA [ ]6].  6]   FROM [ ]  0]   FT TO [ ]  4]1]4]FT	MATL[S]T]L]
2 CASING DIA []]] FROM[]]]FT TO[]]FT	MATL
3 CASING DIA []]] FROM[]]]FT TO[]]]FT	MATL[]]
4 CASING DIA []]]] FROM[]]]]FT TO[]]]]FT casing matl codes brs=brass cop=copper evd=everdur irn=iron pls=plastic stl=steel sst=stainless steel	MATL[]]] mon=monel
1 CASING PERFORATED FROM [ ] [3 8 0]FT TO[ ] [4 1]4 FT OPEN	ING TYPE [P]
2 CASING PERFORATED FROM [ ] ] ] FT TO[ ] ] ] FT OPEN	ING TYPE ]
3 CASING PERFORATED FROM []] FT TO[]] FT OPEN	ING TYPE
4 CASING PERFORATED FROM []] FT TO[]] FT OPEN	ING TYPE
5 CASING PERFORATED FROM [ ] ] ] FT TO[ ] ] ] FT OPEN opening codes: f=fractured rock, l=louvered or shutter-type of m=mesh screen, p=perforated, porous, slotted casing, r=wire-word s=screen, type unknown, t=sand point, w=walled or shored, x=opening to the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the content of the cont	screen, und screen
FUNDED BY: TRIVER ] ] CONTRACTOR: [TRIVER] ] ]	
SITE IMPROVEMENTS  () WM WINDMILL  () AL AIRLIFT  () EM ELECTRY  () WP WATERING POINT  () TO TURBINE  () HA HAND  () WL WATER LINE  () MT MULTIPLE  () CS CISTERN  () CN CENTRIFUGAL  () HP HAND PUMP  () MC MULTIPLE  () CM WINDMILL  () MC MULTIPLE  () WM WINDMILL  () NO NONE  () BU BUCKET  () SU SUBMERSIBLE	IC MOTOR ENGINE SINE
PUMP HP []]] ON SITE STORAGE CAPACITY []2]7]9]0] GA	
STRUCTURE DATA SOURCE: [7]8]19] ] ] ] ] ] ] ] ] ] ] ] ] ] ] ]	
STRUCTURE FILE COMPLETED BY: M.2. DA rev:840426 form: well	TE 1019   1984 record str







## TRIBAL WELL RECORD COMMENTS FILE

TRIBAL WELL NO [/]6]7]-[S]2]/]]]]

MMENTS: What quality improvation so file.  — Additional core gallers clevaled tank for winter lauding ENTERED OCT 13 1986  ENTERED OCT 13 1986	MMENTS: Water quality.	enformation so fele:
	- Additional 1000 ga	Hons elevated tank for water facilis.
	•	ENTERED OCT 13 1485
v-940430 form: well record co		
2-840430 form: well record or		
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7,070750	v:840430	form: well record com

#### WELL RECORD

Water Well Development Navajo Tribe Window Rock, Arizona

Project #6537 WELL NO 16T-521

Quad. No.	119	Mile	. west	10.5	и	iles south	10.0	
6 mil	es East	of Prewi	tt, New	Mexico				
Location								
_						November		3
Diameter	of well	8''		Depth	of well	414'		
						Recovery		
Quantity (	of water on t	est run: baile	er: pump:_	3	G. P. M	. Tested for	3	hours
Kind of ca	asing: 6-5	/8'' si	zes and len	gth 380 '	- 414	Perforat	ed	
Screen ki	nd	L	ength			Mesh		
Contracto	THE NA	VAJO TRI	BE	Addre	ss Wir	dow Rock,	Arizona	1
Drifte	rs: G. 1 Depth	villiams,	Seli	LOG				
From	То	Fo	rmation		Acquifer		Remarks	
0	40	Alluvi	um Fill		···			
40	120	Sandst					<del></del>	<del></del>
120	205	Gray I	ime - F	lard				<del> </del>
205	230	White	Lime			-		
230			ime Har	d				
260	280		one Har					
280	380	Sandst	one Hai	rd				
380	410			oft Water	)			
410	414	White	lime ha	ard				
							<del> </del>	_ <del></del>
April 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10								
							···	
		<del></del>	<u>-</u>				· · · · · · · · · · · · · · · · · · ·	
				<del></del>				
Remarks:							· · · · · · · · · · · · · · · · · · ·	
S.P. 7	50 Te	mp: 78°	)					
Teta Salts	Calcium Ca.	Magnesium Mg.	Sodium Na.	Chlorides CL	Sulfaces SO 4	Carbonates HCO 3	Р.Н.	CO 3
Excellent	Good	Fair	Poor	Doubtful	Not	suitable for do	mestic, lives	stock use
	YYY							

Cylinder size: _ Tubing, cylinder and suction pipe length in feet: 2" x Kind of pump rod: Size of box and pin: 3/4" x 7/8" Liner, if any: __ Windmill: (make) ___Aermotor 16' Size: ___ Storage: (kind) Galv. & steel Capacity: 1,000 gal. & 26,000 gal. Troughs: (kind) No. 2 galv. - 12"x 12"x 12" Comments:

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY 3 10.5 x 10.0 WATER RESOURCES DIVISION WELL SCHEDULE Date 23 December 19.63 Fleid No. 16 F-621 Record by MEGAVOLE Office No. Source of data TRIBAL WELL RECORD - Observe from 1: Location: State New Mexico County ME Kinkey Maple ENE of Present 14 14 000. 18 T 19 PR 10 2. Owner: TRIBE Address Window Rock Tenant ..... ____ Address ____ Driller Bill Self - TRIBLE Address 8. Topography Gentle Slope 4. Elevation 7050 & tt. above 56 5. Type: Dug firilled driven, bored, jetted # 19.63 6. Depth: Rept. 4/4 ft. Moss. 7. Caring: Diam. & Tin, to Trop Server Depth 4/4 ft. Finish 13 Fact. 380 - 414 8. Chief Aquifer Entrada Prom 9. Water look 365 tt 000 11-13 1963 above 25 _which is 10. Pump: Type ____ ... Capacity ... ___G. M. __ Power: Kind ..... ...... Horsepower ... 11. Yield: Flow _____ G.M., Pump ____ G.M., Mess., Rept. Ret. Drawdown 49 ft after 4 hours pumping 3 G.M. 12. Use: Oom, Stock PS., RR., Ind., Irr., Obs. Adequacy, permanence _____Temp__*78*_•F. 18. Quality 5, C. 750 ____ Sample @ 12-63 Taste, odor, color Unfit for _____ 14. Remorks: (Log, Analyses, etc.) Orthers log on well cesued Confacts on back

en jugas befall juli o odkile gladistic

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OVER

6PO 835013

16T-521

1	
ATE REPAIRED	WORK DONE AND MATERIALS USED
8/19/69	Run in sucker rods & made new stand pipe. Used 3/4" x 420' sucker rods.
	$1\frac{1}{4}$ " gate valve, $1\frac{1}{4}$ " x 4" short nipple, 2" x 15' pipe.
8.18.69	Pulled rods
9/12/69 3/17/70	Checked windmill and changed oil.
	Checked windmill, ok.
3/19/70	Releathered cups.
10-16-75	
10-16-15	Till 351 tank is rived.
16-22-25	Removed the sump pack to station 19
	, , , , , , , , , , , , , , , , , , , ,
16T-	Well equipped iwth 16' Aermotor windmill 27,900 gallon storage tank 1,000 gallon Army surplus storage tank elevated where people filled their barrel with drinking water. The big tank is empty.

16T-521	Analytical statement Ariz. 6.16		kinley 3507	//
10.5W x 10.0S	Date of collection NOV. 15	196	epm	T
6 miles NF. of Prew	itt,Ignition LossColor	<b>a</b>		ppm 10
N.II. Drilled	Dissolved Solids:	SIO		10
Navajo Tribe	Residue et 180°C	Fe		<del> </del>
Window Rock, Ariz.	Calculated (Sum) 581			
Mary 162	Tous per Acre Poot 0.79	Co	0.95	19
e deld Nov. 163 cased to 414	ft Hardness as CaCO ₃ 54	Mg	0.13	1.6
ch 414' pt 6 5/8		No		
Entrada	z <u>za 89 saz 12 pz 7.9</u>	K		
er level 365 to below su				
pled after pumping hrs 2 - 3 GPM (mean or est)	(micrombos at 25°C) 912	Na+K	8.86	204
id Z = 3 GPH (mean or est)				
ef collWell		нсо.	6.82	416
Reddish		co,	0.00	0
Dom., Stock		504	2.58	124
Fred Zscach		CI	0.42	15
use EFW		F	0.11	2.0
completed Feb. 14, 1964		NO3	0.01	0.7
iked by JON		3	9.94	

Action and American

1 ...

TRIBAL WELL NO VENT -K	122 11111	PWSID []]	
WELL NAME/OTHER NO []]	111111111	]]]]]]]	11111
WELLTYPE (MARK ONE ONLY)	WELL STAT		L USE ONE ONLY)
WW WATER WELL ( )WA ARTESIAN WELL ( )WS SPRING ( )OW OBSERVATION WELL ( )GS GAS WELL ( )OP OIL PRODUCTION ( )MW MINERAL WELL	( ) ACT ACTIVE ( ) INA INACTIVE ( ) ABA ABANDONE ( ) UNK UNKNOWN  WEST [ ] ].]]	( )AG □	
<del></del>			
NE SE SW NW/NE SE SW NW/N 10 acre 40 acre	E SE SW NW [2]2 [ 160 acre SECT.	T)/13]. DW [ TOWNSHIP	R]/]0].101/07 RANGE
APPROXIMATE LOCATION []			]]]]]]
	LATITUDE[ ] ] ]	longitude[]	111111
UTM COORDINATES: X(east)	7812171914 Y(nort	h) BP1/8161/4	ZONE
OPERATOR [7] BILL INST	USGS WATERSHED	CODE[]]]]	]]]]]
STATE: ( )AZ ARIZONA	NM NEW MEXICO ()	UT UTAH ( )	CO COLORADO
( )NA NAVAJO ( ( )CO COCNINO (	MK MCKINLEY ( ) VL VALENCIA ( ) )BL BERNALLILLO )SD SANDOVAL		
		GRAZING DISTRI	CT //bj
CHAPTER NAME		CHAPTER CO	DE BALLA
LOCATION DATA SOURCE:	r <del>[-]]]]]]]]</del>	11111111	11111
YV LOCATION FILE COMPLETED B	Y:	D.	ATE//_
FIELD CHECKED BY: [ ] ]			ATE/
rev:840425		form:wel	l record loc

## 

ENTERED UT 8 1386

form:well record loc

TRIBAL WELL NO [/]6]7]-[5]5]		PWSID WMC	101010125141
WELL NAME/OTHER NO [4] [4] [7] [5] 7	]A]C]K] ]C]O]M]A	1.)5]Y]S]T]E]	M ]WELLY ]
WELL TYPE (MARK ONE ONLY)	WELL STAT  (MARK ONE ONLY)		L L U S E RK ONE ONLY)
	( ) INA INACTIVE ( ) ABA ABANDONE	(). () ();	DOM DOMESTIC AGR AGRICULT. LIVESTOCK IND INDUSTRIAL MINING REC RECREATION MUN MUNICIPAL OTH OTHER
QUAD NO [/]/] MILES WES	T [1]0].]6]5]	MILES SOUTH	[1]1].]0]0]
NE SE SW NW/NE SE SW NW NE SE 10 acre 40 acre 160	SW NW 20 1	T]]]]]] TOWNSHIP	RANGE
APPROXIMATE LOCATION [/] [M]/	]L]E] ]S]E] ]O]F	]  H A Y S T	ick imou
WITHIUM [ [ [ LATI	TUDE[3]5]2]0]4]5	] LONGITUDE[	1017151512191
UTM COORDINATES: X(east)[]]	]]]] Y(nort	h)[]]]]	] ] ZONE[]]
OPERATOR [7]8]1]2]3]	USGS WATERSHED	CODE[]]]	
STATE: ( )AZ ARIZONA ( )NM	NEW MEXICO ()	UT UTAH (	)CO COLORADO
()NA NAVAJO ()VL ()CO COCNINO ()BL	MCKINLEY (): VALENCIA (): BERNALLILLO SANDOVAL		)HT MONTEZUMA )LP LA PLATA
( )SO ( )RA	SOCORRO RIO ARRIBA SAN JUAN	GRAZING DISTI	RICT [/]6]
CHAPTER NAME BACA		CHAPTER (	CODE [8]A]C]A]
LOCATION DATA SOURCE: [r]	188], ]8]. ]5]7]0	Me) ]RITI-16	9)]]]]]
LOCATION FILE COMPLETED BY:	masuel v. Par	mau	DATE /0 /8 //586
FIELD CHECKED BY: []]]]	ווווווווווווווווווווווווווווווווווווווו	JJ	DATE//_

rev:840425

TRIBAL WELL SORD ENERED OCT 8 1095 WELL NO [/]6]7]-]5]5]1]]] USGS AQUIFER CODE [2]3]1] 3 N S 1 THICKNESS [ ] ] FT NOMINAL YIELD [ ] ] ] GPM YIELD MEASURED _/_/ DRAWDOWN [ ] ] 67FT OBSERVATION WELL DATA AVAILABLE ()YES ()NO HORIZ CONDUCTIVITY ] ] ] ] ] ] FT/DAY SPECIFIC CAPACITY [0] . ] 7] S] GPM/FT After 4 Ars. VERT. CONDUCTIVITY[ ] ] ].] ] FT/DAY STORAGE COEF [.] ] ] COEF OF TRANSMISSIVITY [ ] ] ] | BB FT2/DAY OY 660 GPD/FT. INDICATE ADDITIONAL PUMPING TEST DATA AVAILABLE AS HARD COPY: ( )Y ( )N MULTIPLE RATE DRAWDOWN PUMPING TEST (^)Y ( )N SINGLE RATE DRAWDOWN PUMPING TEST ( )Y ( )N MULTIPLE RATE DRAWDOWN/RECOVERY TEST (V)Y ( )N RECOVERY TEST LOGS AVAILABLE: (VDL DRILLER'S LOG ( )EL ELECTRIC LOG HYDROLOGY DATA SOURCE: [T]R[I]E[E]HYDROLOGY FILE COMPLETED BY: M. 2. DATE 10/8/1986 STATIC WATER LEVEL FILE DEPTH TO SWL 446 FT DATE 9/17/1969 DEPTH TO SWL FT DATE / / ENTERED OF DEPTH TO SWL 4/7 FT DATE 10/7 1976 DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL____FT DATE / / DEPTH TO SWL___FT DATE / / DEPTH TO SWL ____ FT DATE / / DEPTH TO SWL ___ FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL FT DATE / / DEPTH TO SWL ____FT DATE / / DEPTH TO SWL ___FT DATE / / DEPTH TO SWL ____ FT DATE / / DEPTH TO SWL ___ FT DATE / / DEPTH TO SWL ____FT DATE / / DEPTH TO SWL ____FT DATE / /

form: well record hyd

IN

rev:840427

# TRIBAL WELL RECO STRUCTURE FI

WELL NO [/6]7]-[5]5]/]	STARTED 9 /4	1/1969 COMPLETED 9/17/1969
ELEVATION [  6 6 9 0] FT	DEPTH []/[0]8]3] FT	DEPTH MEASURED 9 17/1969
DEPTH IS MEASURED ( )E	STIMATED () REPORTED	well dia. [9].] of a
1 CASING DIA []7].]0]0]	FROM[]]+ 2]FT TO[	1/101813)FT MATL[5]F]C
2 CASING DIA []].]]	FROM TO	]]]]FT MATL[]]
3 CASING DIA []].]]	FROM[]]]FT TO[	]]]]FT MATL[]]
4 CASING DIA []].]] casing matl codes brs=bras pls=plas	FROM[]]]]FT TO[ ss cop=copper evd=evero stic stl=steel sst=stai	dur irn=iron mon=monel
1 CASING PERFORATED FROM ]		S]3FT OPENING TYPE [P]
2 CASING PERFORATED FROM ]	]	FT OPENING TYPE
3 CASING PERFORATED FROM J	]]]FT TO[]]	] FT OPENING TYPE []
4 CASING PERFORATED FROM ]	FT TO	TT OPENING TYPE
5 CASING PERFORATED FROM Jopening codes: f=fractured m=mesh screen, p=perforate s=screen, type unknown, t=sz=other DATE WELL TURNED OVER TO T	rock, 1=louvered or sed, porous, slotted casin and point, w=walled or	hutter-type screen, g, r=wire-wound screen
FUNDED BY: []]]]]	CONTRACTOR: []]	
SITE IMPROVEMENTS ( ) WM WINDMILL ( ) WP WATERING POINT ( ) TA TANK ( ) WL WATER LINE ( ) TR TROUGH ( ) CS CISTERN ( ) HP HAND PUMP ( ) NO NONE	( )AL AIRLIFT ( )PS PISTON ( )TU TURBINE ( )MT MULTIPLE TURBINE ( )CN CENTRIFUGAL ( )MC MULTIPLE CENTRIFUGAL ( )BU BUCKET	ENERGY SOURCE  ( ) EM ELECTRIC MOTOR ( ) DE DIESEL ENGINE ( ) HA HAND ( ) GS GAS ENGINE ( ) LP LP GAS ENGINE ( ) NG NATURAL GAS ENGINE ( ) WM WINDMILL ( ) SO SOLAR
	( ) SU SUBMERSIBLE	
PUMP HP []]] ON SIT		] ] ] ] GAL
_	18/18/2]]]]]	111111111111
TRUCTURE FILE COMPLETED BY	T:	form: well record str



### TRIBAL WELL NO VIGITI-ISISIVI ) ] ] ]

COMMENTS: The Haystock Community System serves approximately
140 homes in the area ( Dale Cartinel INS Engineer's latter to
Arison James Fr. February 5, 1979) .
@ A bailer test was also run @ 20 Gem for 6 hours.
the Drawdown was 41 fest on september 17, 1969.
* T Calculated from IHS Perup Test data Time / Brawdown
Surve on file.
DD Originally the well was used as a stock well and
used to have a windmill, storage tank, trough etc.
Mow well is being essed for Haystack Community
water Supply System Since December 20, 1976 and
has an electric pump, water tank and a complete
Control house and the weater distribution systems.
Water quality information on file. Water quality
es acceptable for Public water supply.
- joverette easement is on file
ENTERED OCT 9 1986
rev:840430 form: well record com

#### WELL

Water Well Development Navajo Tribe Window Rock, Arizona



WELL NO 16T-551

Quad. No	119	Mile	s west	10.65	Mile	s south 11	.00	
1 mil	e SE of	Haystack	Mounta	in				
Location			*******				_~-	<del></del>
Began wel	Septer	mber 11,	1969	Finished	i well	September	17, 1	969
				Depth o			<del> </del>	
Static wate	er level	146'	Dr	awdown	41'	Recovery _	····	· · · · · · · · · · · · · · · · · · ·
			-			ested for	66	hours
PERFOR	RATION:	See Atta	iched Sr	gth 7" Ol leet		(esh		
Contractor	THE NAV	ZAJO TRIE	3E	م الدائد A	Window	Rock, Az		
DRILLER	S: B. Y	azzie & f	. Sam	Addres	AILING	- 2500 Ro	tarv	·
Ď	EPTH		,	LOG				
From	To	For	mation	A	.cquifer	;	Remarks	
0	55	TODS	oil bro	own sand	- soft			<del></del>
55	79	Black	Volcar	nid mater	ials - h	ard		
79	180		shale -					
180	190			nd white	clay - s	oft		<del></del>
190	255			d purple			<del>-,</del>	
255	350		shale -				<del></del>	
350	376				sandsto	ne - soft	····	
376	465		shale -					
465	470	Red s	shale ar	nd purple	and whi	te sandst	one -	soft
470	803		shale -				<del></del>	<del></del>
803	807			vhite san	dstone -	soft		
807	819			ole shale				
819	822		e sands		**************************************		<del></del>	<del></del>
822	911				red san	dstone -	soft	
911	916		clay -					<del></del>
916	935			ite sands	tone - s	oft	<del></del>	
935						t and har	đ	
							<del></del>	
Remarks:								
S.P.					<del></del>			
Teta Saits	Calcium Ca.	Magnesium Mg.	Sodium Na.	Chlorides CL	Sulfates SO 4	Carbonates HCO 3	P.H.	CO 3
Excellent	Good	Fair	Poor	Doubtful	Not en	itable for dom	ectic live	ectools use
	3000	- 84	1 001	Dodbud	1101 84	WOLE TOU MOUI	C301C, 11V	COLUMN COSC

_WELL No.__

DATE REPAIRED	WORK DONE AND MATERIALS USED
10/22/59	Set windmill tower and level.
10/27/69	saplaced 24-21'-0" x $2\frac{1}{2}$ tubing (pipe), 25-21'-0" x $3/4$ " (pipe) sucker rods,
	$4-21\frac{1}{2}$ " x 1 7/8" leather cups and $2\frac{1}{2}$ " cylinder.
12/22/69	Replaced 19-3/4" $\times$ 21'-0" sucker rode. 18-2 $\frac{1}{2}$ " $\times$ 21'-0" tubing and 2 $\frac{1}{2}$ " $\times$ 36"
	cylinder.
1/12/70	Set up 12' aermotor head and connected pump rod.
2/17/70	Releathered plunger and foot valve. Installed 4,000 gal storage tank, 14" x 2' pipe, 14" stop & waste valve,
2/25/70	
	5-14" ell.
3/17/70	Checked windmill. ok.
2-15-72	6 gal. alumuim and 2 gal. alumuim brust.
09-27-74	CHANGED OIL
3/19/75	Checked.
16:	Well is equipped with 12' Aermotor, two (2) steel trough, 27,900 gal. storage tank. A new concrete floor needs to be pour for windmill base. It laso needs a tank cover for 27,900 gallon storage tank. The well is being use for domestic use
	two steel trough, 6 5/8" casing, 2" tubings, this well has 33,849' of waterline with 7 drinkers. The tank was full when inspected.
W.	



DATE REPAIRED	WORK DONE AND MATERIALS USED
10/22/69	Used sucker rods, $2\frac{1}{2}$ " pipes for corner post, 2" pipe for grit and cross braces
	out of sucker rods.
11/20/69	Installed 14' aermotor, 2" x 21' pipe, 2-2" close nipples, 2" tee, 2" elbow
	and 2" short nipple.
1/13/70	Repainted windmill tower.
2/5/70	Installed 4,000 gal storage tank, $1\frac{1}{4}$ " x 2' pipe, $1\frac{1}{4}$ " stop & waste valve,
	5-l÷" elbow.
3/17/70	Welded leak on storage tank.
7/17/73	Repaired the 100 DC pump jack motor. Replace 12" stop and waste valve.
09-27-74	changed oil
	Replaced stop and waste.
16:22-75	Welded leaky 4, tot got. tonk (Haystack)
f 16T-	This well was turned over to the Public Health Service to be use it for
	86-121 project, 27,900 gallon storage tank is still existing on this well
17 30 01	
7-30.81	METER REHOING
8-11-81	METER READING
10-2-81	Do Fr. A. 4
10-9-81	Routine Inspection
10-13-81	THE TANK 11/2 & METER READING
10-19-51	ROUTENE INSPECTION
10-26-81	THIS PROCE TION
4-4-81	meter Reading
7-8-81	Jank 10'
9-14-81	Routine Check
9.18-81	Meter Reading
10-2-81	Routine Inspection. ${\cal J}$
7 10-9-81	Routine Inspection.
10-13-81	Tank 113/ Meter Reading
10-19-81	Routine Inspection.
10-26-81	Inspection
07-30-81	Meter Reading
08-11-81 08-14-81	Meter Reading
00-14-01	Meter Reading
_	

# L C.TION FILE

		ENTERED OCT 8 1986
TRIBAL WELL NO [/]	-)5/5/24 ] ] ] ] ]	
WELL NAME/OTHER NO []		בנעבווונבנווווו
WELLTYPE (MARK ONE ONLY)	WELL STAT (MARK ONE ONLY)	WELLUSE (MARK ONE ONLY)
( ) WW WATER WELL ( ) WA ARTESIAN WELL ( ) WS SPRING ( ) OW OBSERVATION WE ( ) GS GAS WELL ( ) OP OIL PRODUCTION ( ) MW MINERAL WELL	( )ABA ABANDONET	( )AGR AGRICULT.
QUAD NO [/]/] MI	LES WEST [/]2].]6]5]	MILES SOUTH []9].[9]5]
NE SE SW NW NE SE SW N 10 acre 40 acre	W/NE SE SWNW [/]4] [1 160 acre SECT.	TOWNSHIP RANGE
APPROXIMATE LOCATION I	1) MILLER IMEISITI	IOIFI JHIAJYISITJAJCJKI I I
MOWWITHIN ]	LATITUDE[3]5]2]1]1]3	LONGITUDE[/]0]7]5[2]2[8]
UTM COORDINATES: X(eas	t)	a)[]]]]] zone[]]
OPERATOR [T]K] / ]E]E]	J J J J USGS WATERSHED C	CODE[]]]]]]]
STATE: ( )AZ ARIZONA	(In new mexico ()	TT UTAH ( )CO COLORADO
COUNTY: ( ) AP APACHE	( )MK MCKINLEY ( )S ( )VL VALENCIA ( )K ( )BL BERNALLILLO ( )SD SANDOVAL ( )SO SOCORRO ( )RA RIO ARRIBA ( )SA SAN JUAN	SJ SAN JUAN ()MT MONTEZUMA KA KANE ()LP LA PLATA  GRAZING DISTRICT [/]S
CHAPTER NAME <u>EACA</u>		CHAPTER CODE [8]A]C]A]
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VERT. CONT	.]]] PT/DAY STORAGE COEF [.]]]]
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WELL NO [/]6]7]-[S[5]2]]]]] STARTED 9 126 12767 COMPLETED 1019 1919
ELEVATION [ ]6]6]5]5] PT DEPTH [ ]/ [2]6]6] FT DEPTH MEASURED 10/9 1/987
DEPTH IS ( MEASURED ( ) ESTIMATED ( ) REPORTED WELL DIA. [ ]9].] IN
1 CASING DIA []7].]0]0] FROM[]]+]2]FT TO[]/[2]6]6]FT MATL[5]7]
2 CASING DIA []]] FROM[]]]FT TO[]]]FT MATL[]]
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4 CASING DIA []]] FROM[]]] FT TO[]]] FT MATL[]] casing matl codes brs=brass cop=copper evd=everdur irn=iron mon=monel     pls=plastic stl=steel sst=stainless steel
1 CASING PERFORATED FROM [ ] [9]7]5]FT TO[ ]/]/]3]7]FT OPENING TYPE [P]
2 CASING PERFORATED FROM []/]/]/OFT TO[]/]2]0]3]FT OPENING TYPE [P]
3 CASING PERFORATED FROM [ ]/]2]3]6 FT TO[ ]/]2]7]0 FT OPENING TYPE [P]
4 CASING PERFORATED FROM []]] FT TO[]] FT OPENING TYPE []
5 CASING PERFORATED FROM [ ] ] ] ] FT TO[ ] ] ] ] FT OPENING TYPE [ ] opening codes: f=fractured rock, 1=louvered or shutter-type screen, m=mesh screen, p=perforated, porous, slotted casing, r=wire-wound screen s=screen, type unknown, t=sand point, w=walled or shored, x=open hole z=other  DATE WELL TURNED OVER TO TRIBE: / /
FUNDED BY: TRIBE   CONTRACTOR: TRIBE   ] ] ] ] ] ] ] ] ] ] ] ]
SITE IMPROVEMENTS  ()AL AIRLIFT ()EM ELECTRIC MOTOR ()YPS PISTON ()DE DIESEL ENGINE ()TA TANK ()TU TURBINE ()HA HAND ()TR TROUGH ()CS CISTERN ()CN CENTRIFUGAL ()HP HAND PUMP ()MC MULTIPLE ()MC MULTIPLE ()HO NONE ()SU SUBMERSIBLE
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TRIBAL WELL NO [/]6]7]-]5]5]2]]]

PERTINENT COMMENTS: 8 33.849 feet of	mater live.		
Wale quality information	on file.		
COMMENTS: @ 33,849 per of  Waln quality information  property assement of	n file EN	TERED OCT	9 1986
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		nagan an de se se se service services	
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#### WELL RECORD

Water Wei . 12.0 / Sec. Navajo Tril 552 WELL Window E Quad. No. 119 . Miles west 12.65 Miles south 9.95 1 mile West of Haystack Mountain; NE, SW, Sec. 14, T13N, R11W N.M.P.M. Location Began well September 26, 1969 Finished well October 9, 1969 1268' Diameter of well _____ Depth of well ____ Static water level 362' Drawdown None Recovery Quantity of water on test run: bailer: pump: 18 G. P. M. Tested for 6 hours Kind of casing: T & C Sizes and length 7" x 1270' Perforation: See Casing Tally Screen kind_____ _ Length____ Contractor THE NAVAJO TRIBE Address Window Rock, Arizona Driller: Bob Yazzie, Jim Sam LOG From To Acquifer Remarks Formation Top soil brown to red - soft 0 22 22 30 White sandstone - soft 30 42 Red sandstone - soft 42 White to red sand & lime streak - Hard 50 Red & blue shale & lime spot - soft 50 206 206 Red shale - Soft 280 280 715 Red & purple_shale - soft 715 760 Red shale - hard 760 765 Brown & blue lime stone - very hard Red shale - soft 765 888 Red shale & lime streak - hard 932 888 Fine grained white sandstone, blue & purple shale - soft 932 1000 White clay and fine grained white sandstone - soft 1000 1013 Grey to white sandstone & silt stone - soft 1013 1050 Blue shale, silty sandstone & grey limestone - hard 1050 1080 Purple red shale & white sandstone - hard 1098 1080 Fine grained white sandstone & blue to white clay 1098 1119 Grey lime stone & fine reddish sandstone - hard 1119 1260 Remarks: S.P Teta Calcium Magnesium Sodium Chlorides Sulfates Carbonates P.H. CO Salts HCO Ca. Mg. Na. CL SO 3

Doubtful

Not suitable for domestic, livestock use

Excellent

Good

Fair

Poor

		•		Page 2	of 2 Pages		
				Well No	16T-552		
Quad. No	1	119 Miles we	st <u>12.65</u>	Miles south_	9.95		
Location: 1 mile West of Haystack Mountain; NE, SW, Sec. 14, Tl3N,							
				RIIW, N.M.P.	М.		
			LOG				
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FROM	TO	1	FORMATION		REMARKS		
1260	1268	Purple shale -	soft				
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REMARKS:	T.Ost	circulation 940	); to 944;		•		
REMARKS: Lost circulation 940' to 944'							
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UNITED STATE CHARLES

# Memoranich

To : Ejars

Hydrolog....

Water and Sanitation, Navajo Tribe

FROM :

Field Engineer

Crownpoint Service Unit

SUBJECT:

Windmill 16T-552

As per our visit to the Haystack project area, July 13, 1976 and our discussion of the same date concerning the possible use of the subject windmill, please supply this office with any information you have on this well such as total depth, screened depth, static water level, test pumping data and drillers leg.

DATE: August 16, 19

Preliminary results of the chemical analysis for the subject well follow:

Boron	1.02  mg/1
Fe	0.28 "
Ca	2.00 "
Mg	Trace
Na.	190.82  mg/1
K	2.74  mg/l
P	0.0218  mg/1
нсо3	165.92 mg/l
co3	76.80 mg/l
Cl	26.59 mg/l
T	0.89 mg/l
Total F	0.4998 mg/1
EC	850 micromhos/cm
pН	9.1

Based upon this data and the analyses remaining, it appears that test pumping of this well may be feasible.

Your prompt attention to this matter will be appreciated.

Robert Mayers, Field Engineer

1 1014

RM/ejb

cc: File/chron



T 11 W, R 13 N, Section 14,  $SW_4^1$  of  $NW_4^1$  N M P M Sept. 22, 1969

A well drilled at this location would start at approximately 6900 feet elevation, and be situated about a mile west of Haystack Mountain. This well will be identical to the well just completed in T 13 N, R 10 W, Section 20,  $SW_4^1$ , 16T-551, with the following exceptions: The new well will not encounter a surface basalt flow and, the new well may begin slightly higher in the section with some Wingate sandstone present.

The quality and quantity of the water will be the same as found in 16T-551.

The anticipated geologic section is as follows:

Formation	Depth (ft.)	Description
Wingate Sandstone	0 - 50	Sandstone, brown to reddish
Chinle Formation Upper Member	50 - 240	Siltstone, limy; pale bluish-gray or olive gray to dark greenish- gray
	240 - 390	Siltstone; reddish brown
Correo Sandstone Member	390 - 465	Sandstone; pale-grayish- red with some gray to pale-brown pebble conglom- erate
Middle Member	465 - 865	Siltstone; reddish-brown
Sonsela Sandstone	865 - 1165	Sandstone, conglomerate; white, pale-yellowish-brown, yellow, and brown

W. L. Werrell Hydrologist

# TRIBATE RORD ENTERED OCT 6 1986 FULL

TRIBAL WELL NO [/]6]7]-]5]6]	द्यागा	PWSID WMC	100101215141
WELL NAME/OTHER NO [M]A]Y]S]	r]A C K  ]R]U)R]A	IL) JWA)TJE)	R) S)UP)LJY]
WELL TYPE (MARK ONE ONLY)	WELL STAT  (MARK ONE ONLY)		L L U S E RK ONE ONLY)
( ) WW WATER WELL ( ) WA ARTESIAN WELL ( ) WS SPRING ( ) OW OBSERVATION WELL ( ) GS GAS WELL ( ) OP OIL PRODUCTION ( ) MW MINERAL WELL	( )ACT ACTIVE ( )INA INACTIVE ( )ABA ABANDONE	( ) ( ) ( )	DOM DOMESTIC AGR AGRICULT. LIVESTOCK IND INDUSTRIAL MINING REC RECREATION MUN MUNICIPAL OTH OTHER
QUAD NO [/]/] MILES WE	ST [/]0].14]5]	MILES SOUTH	[19].180]
NE SE SW NW/NE SF SW NW NE S 10 acre 40 acre 160	ecre SECT.	TOWNSHIP	[R]/]0].]0]W] RANGE
APPROXIMATE LOCATION [N]E]A]	R] ]#]A]Y]S]T]A]c	K   M 0 U N	T]A]I]W]]]]
[]]]]]] LAT	ITUDE [3]5]2]1]4]3	LONGITUDE [	1]0]7]5]6]0]2]
UTM COORDINATES: X(east)[]	]]]]] Y(north		] ZONE[]]
OPERATOR [7] R] [8] E] ] O] 4] M]	USGS WATERSHED	CODE	
STATE: ( )AZ ARIZONA (V)NM	NEW MEXICO ()	T UTAH (	)CO COLORADO
			)MT MONTEZUMA )LP LA PLATA
( )SO ( )RA		GRAZING DIST	RICT [/]6]
CHAPTER NAME BACA		CHAPTER (	CODE [8]A]C]A]
LOCATION DATA SOURCE: [7]A]A	181E],](]MS],]B	· ]5]T]0]N]E]	JR]T]-[6] ] ]
LOCATION FILE COMPLETED BY:	Masud U.	Pamer	DATE 10/3/1986
FIELD CHECKED BY: []]]]	<u>רררנינייי</u>	<u>]_]</u>	DATE/
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TRIBAL WALL FEED OCT 6 1986 PAR DROLL FEED O

MELL NO 1/16//1-15/10/61 1 1 1 1	USGS AQUIPER CODE
THICKNESS TITT NOMINAL YIELD	GPM YIELD MEASURED _/_/
( )BAILER ( )PUMP TEST @ [ ] ]9]0]G	PM FOR 12 4 . O HOURS DATE _/_/
DRAWDOWN [] ] ]9]9]FT OBSERVAT	ION WELL DATA AVAILABLE ()YES (2)NO
HORIZ CONDUCTIVITY [ ] ].] ] PT	/DAY SPECIFIC CAPACITY ] ] GPM/FT
VERT. CONDUCTIVITY[]]]] F	T/DAY STORAGE COEF [.]]]]]
COEF OF TRANSMISSIVITY [ ] ] ] ]	•
INDICATE ADDITIONAL PUMPING TEST DA  ( )Y ( )N MULTIPLE RATE DRAWDOWN PU  ( )Y ( )N SINGLE RATE DRAWDOWN PUMP  ( )Y ( )N MULTIPLE RATE DRAWDOWN/RE  ( )Y ( )N RECOVERY TEST	MPING TEST ING TEST
LOGS AVAILABLE: (V)DL DRILLER'S LOG	(VEL ELECTRIC LOG
HYDROLOGY DATA SOURCE: [/]H]S]	
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# RIBAL WELL RECORD * 1 3

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1 CASING DIA [ ]6]. 16]2	FROM ] ] ] ] ] O FT TO	1/15/5/5/PT HATL[S]T]L]
2 CASING DIA []].]]	FROM TO	]]]]FT MATL[]]
3 CASING DIA []]]]	FROM[]]]FT TO[	]]]]FT MATL[]]
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2 CASING PERFORATED FROM	[]/]4]3]2]FT TO[]/]4]	9]5]FT OPENING TYPE [P]
3 CASING PERFORATED FROM	[ ]/]S]0]S]FT T0[ ]/]S]	5]6]FT OPENING TYPE [P]
4 CASING PERFORATED FROM	[]]]FT TO[]]	] FT OPENING TYPE
5 CASING PERFORATED FROM opening codes: f=fractur m=mesh screen, p=perfora s=screen,type unknown, t z=other DATE WELL TUPNED OVER TO	ed rock, 1=louvered or s ted,porous,slotted casin =sand point, w=walled or	g, r=wire-wound screen
FUNDED BY: [/]#]S] ] ]	] ] CONTRACTOR: [r]R]	/1812]]]]]]]
SITE IMPROVEMENTS  () WM WINDMILL () WP WATERING POINT () TA TANK () WL WATER LINE () TR TROUGE () CS CISTER' () HP HAND PUMP () NO NONE	( )AL AIRLIFT ( )PS PISTON ( )TU TURBINE ( )MT MULTIPLE TURBINE ( )CN CENTRIFUGAL ( )MC MULTIPLE	ENERGY SOURCE  ( ) EM ELECTRIC MOTOR ( ) DE DIESEL ENGINE ( ) HA HAND ( ) GS GAS ENGINE ( ) LP LP GAS ENGINE ( ) NG NATURAL GAS ENGINE ( ) WM WINDMILL ( ) SO SOLAR
PUMP HP []]]] ON S	ITE STORAGE CAPACITY []	] ] ] ] GAL
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Perforation Squirt chine Formation

### E S L WELL RECORD

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NE SE SW NW/NE SE SW N 10 acre 40 acre	NE SE SW NW [/]8] 160 acre SECT.	[T]/[3].]o]M TOWNSHIP	[R]/]0].]0]W RANGE
FT-E/W []]]]]	]]]]] FT-N/	's []]]]	1111111
UTM COORDINATES: X(eas	t)	north)[]]]]	]
STATE: ( )AZ ARIZONA	(Inm new mexico	( )UT UTAH	( )CO COLORADO
COUNTY: ( ) AP APACHE	( )MK MCKINLEY ( )VL VALENCIA ( )BL BERNALLILLO ( )SD SANDOVAL	( )SJ SAN JUAN ( )KA KANE	( )MT MONTEZUMA ( )LP LA PLATA
	( )SO SOCORRO	DEPTH OF HOLE	[ ]2]4]0]0] FT
	()SA SAN JUAN	BIT SIZE/DIA.	
LOG FILE COMPLETED BY:	******	M· E	DATE 10   6   1900
TRIBAL WELL NO [/]6]7]	-]5]8]6]]]]]		14/04/12
TRIBAL WELL NO [/]6]7] WELL NAME/OTHER NO []	]]]]]] -]SI&]6]]]]]]		11111111
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WELL NAME/OTHER NO TYPE OF LOG [C]A]L]I]I	บบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบบ	DATE LOGGED [/	
WELL NAME/OTHER NO TYPE OF LOG [C]A]L]/]A		DATE LOGGED [/	[R]/]0].]0]m]
WELL NAME/OTHER NO []  TYPE OF LOG [C]A]L]I]I  NE SE SW NY/NE SE SW NY  10 acre 40 acre		DATE LOGGED [/	[R]/]0].]0]\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
WELL NAME/OTHER NO TYPE OF LOG [C]A]L]/]AND SE SW NW/NE SE SW NW 10 acre  FT-E/W []]]]]		DATE LOGGED [/	[R]/]0].]0]\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
WELL NAME/OTHER NO TYPE OF LOG [C]A]L]I]  NE SE SW NW/NE SE SW NY  10 acre 40 acre  FT-E/W []]]]]  UTM COORDINATES: X(east  STATE: ( )AZ ARIZONA  COUNTY: ( )AP APACHE	W/NE SE SW NW [/]E]  160 acre SECT.	DATE LOGGED [/ ] ] ] ] ] ]  [T]/]3].]o// TOWNSHIP  S [] ] ] ] ]  orth)[] ] ] ]  ( )UT UTAR	[R]/]0].]0]\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
WELL NAME/OTHER NO TYPE OF LOG [C]A]L]/]  NE SE SW NW/NE SE SW NO 10 acre  FT-E/W []]]]  UTM COORDINATES: X(east STATE: ()AZ ARIZONA  COUNTY: ()AP APACHE ()NA NAVAJO	M/NE SE SW NW [/E] 160 acre SECT.	DATE LOGGED [/ ] ] ] ] ] ]  [T]/]3].]o// TOWNSHIP  S [] ] ] ] ]  orth)[] ] ] ]  ( )UT UTAH  ( )SJ SAN JUAN ( )KA KANE	[R]/]0].]0]\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

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### TRIBAL WEL COPP D

### TRIBAL WELL NO [][]]]

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(x) Static water level 4	med. 17 feet when well tapped ly, Psa at
Perforated opposite Beps	and retested, Ep. Cord. 33810 mmhos
Well despend to 2,400, Specific Conductores 2042	feet Kroush Repeint Psa, Pg and test.
backed : Specific Conductor	drilled to 733 feet dept, lossed and

#### WELL RECORD

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24 34

500 to 16T-586 cizona Quad. No. 119 (S.W.) \( \) Miles west 10.45 Miles south 9.80 NWs. NEw. Section 18.713 N R 10W. Haystack, New Mexico Location Began well ______ Finished well _____ January 05, 1976 Diameter of well __10-5/8 inch ____ Depth of well __ Static water level 580 feet Drawdown none Recovery none Quantity of water on test run: bailer: pump: 8.5 G. P. M. Tested for 12 hours Kind of casing: T/C Sizes and length 8-5/8 inch 0.0. X 1555 feet
1400 feet - 1421.57 feet
Screen kind Machine slotted ength 1431.57 feet - 1495 feet
1505 feet - 1555 feet Contractor The Navajo Tribe <u>Water and Sanitation Division</u> _____ Address ____ Drillers: Jerry Barney
Steven Yazzie Post Office Box 678 LOG Fort Defiance, Arizona Acquifer From Formation Remarks To <u>0'</u> 70' Surface Soil - Fine sand Soft 70' Red and White sandstone with yellow gravels 110' Soft 110' 120' Red and white sandstone Soft Soft 120' 140' Red, white and gray sandstone 140' Soft 150' Red sandstone 150' 250' Pink to white sandstone Soft 250' 2601 Gray and light red sandstone Soft 260' 2801 Lime stone Hard 280' 290' White and red sandstone Soft 2901 4551 Orange sandstone Soft 455' 480' Orange and white sandstone Soft 4801 5501 <u>Orange sandstone</u> Soft 550 5601 Orange shale Soft 560' 9381 Orange white and brown shale with sandstonee Soft 9381 1214' Red and blue sandstone Hard 1214' 13751 Clav Hard 1375' 1420' Red. brown and purple shale with white sandstone Hard Surface casing: 12% inch to 200 feet Remarks: S.P. P.H. Teta Calcium Magnesium Sodium Chlorides Sulfates Carbonates CO Salts Ca. CL SO HCO Na. 3 Mg.

Doubtful

Not suitable for domestic, livestock use

NTRD - 61

Excellent

Good

Fair

Poor

^{*} The hole was drilled up to 1718 feet.. The hole caved in up to 1686 cement plug was set from 1686 to 1555.

#### WELL RECORD

				<b>5</b> ,	*			
Ground Wa		lopment			1	Page 2	of	Pages
Window Ro		ona			ţ	VELL NO.	16T-586	
Quad. No.	19	(SW½)	Miles west	10.45	Mile	s south	9.80	
Location:	NW1.	NE½, S	ection 18.T13 N	R 10W, Hay	stack, Ne	w Mexico		
				LOG				
							<u> </u>	
DEP								_
1420'	To 1489'	R	FC ed shale with wh	RMATION are	av sandsti	ne	REMARK!	S
1489'	1555'	R	ed shale			7116	Soft	
1555'	1718'	P	urple, light blu	e and red	shale		Hard	
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REMARKS:								
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MAYALO CINCOLOGIA CONGOCIAL CONGOCIA

HYDROLOGY OF AREA 62, NORTHERN GREAT PLAINS AND ROCKY MOUNTAIN COAL PROVINCES, NEW MEXICO AND ARIZONA

BY

F. E. ROYBAL, J. G. WELLS, R. L. GOLD, AND J. V. FLAGER

U.S. GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS OPEN-FILE REPORT 83-698



2.0 GENERAL FEATURES--Continued 2.4 Soils

Light-Colored Low Humus Soils Predominant

Soils vary with landscape and are different on flood plains, hillslopes, and mountain slopes.

The soils of Area 62 are separated into 18 mapunits as described in figure 2.4-1. These map units have been grouped into three broad categories classified largely with respect to climate, to topographic setting, and to soil colors. The color of soil generally relates to the amount of humus present with dark-colored soils containing more humus than light-colored soils. The three categories are described below.

The "light colored soils of the cool plateau region" (map units 1 to 8) (fig. 2.4-2) are dominated by Torriorthents and Haplargids groups. These soils are dry and (or) salty. The soils principally are derived from sandstone, shale, and limestone. Soils of this category mainly are present on gently sloping and undulating landscapes, but also on steeply sloping and rolling ridges. The texture of this soil category ranges from sandy loam to heavy clay loam.

The "moderately dark colored soils of the cool plateau region" (map units 9 to 12) are dominated by Argiustolls and Rockland groups. Soils are primarily derived from volcanic rock and limestone. Soils of

this category are on steeply sloping mesa tops and steep to very steep slopes and escarpments. These soils generally have surface layers of stony loam, clay loam, and fine sandy loam.

The "moderately dark and dark colored soils of the cool to cold mountain region" (map units 13 to 18) are dominated by the Eutroboralfs group. Soils are weathered from sandstone, shale, limestone, and basalt. Generally, soils are deep on nearly level valley areas. Soils are shallow on steep to very steep mountain slopes. The soil texture ranges from loam to clay. The soils in this category are located within the zones of greatest precipitation and highest altitude of Area 62.

More detailed information on the soil types described in this report are available from reports by Maker and others (1972, 1974, 1978). For the soils scientist involved in planning for reclamation of mined land, the report by the U.S. Department of Agriculture (1979) might also be useful.

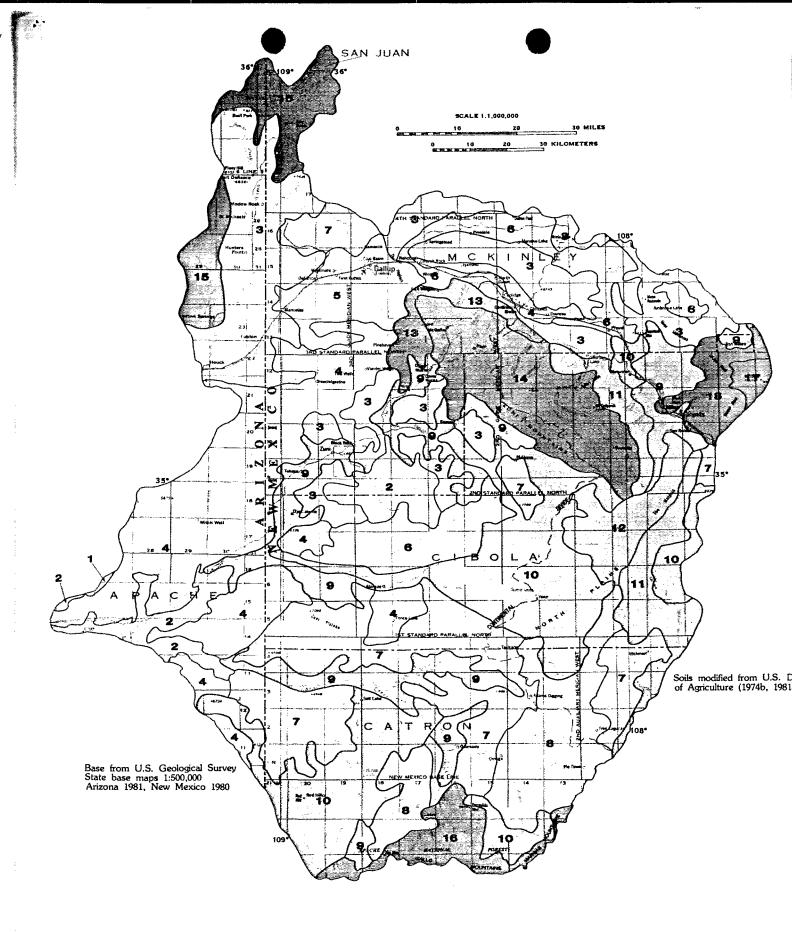


Figure 2.4-1 General soil map.

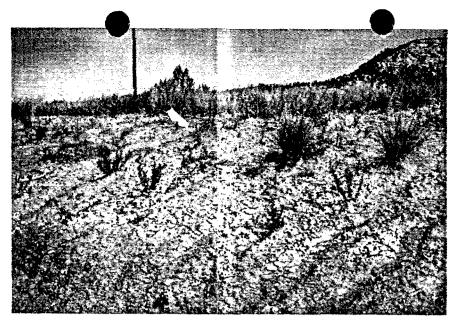


Figure 2.4-2 Light-colored soils (south of Gallup, New Mexico).

EXPLANATION

(>,greater than)

Map Symbol	Map unit	Topographic setting	Soll depth (inches)	Slope (percent)	Altitude above sea level (feet)
	LIGHT COLORED SOILS OF THE COC	DL PLATEAU REGION			
1	Badland-Torriorthents-Torrifluvents	Hillstopes, ridges, flood plain	0-60	0-60	5,500 to 6,000
2	Torrifluvents	Flood plain, alluvial fans	>60	0-2	5,500 to 7,000
3	Rock outcrop-Torriorthents-Haplargids	Canyon walls, hillslopes, plains	0-40	1-70	5,800 to 7,500
4	Haplargids-Torripsamments-Torrifluvents	Plains, stabilized dunes	>60	8-0	5,500 to 7,500
5	Torriorthents-Rock outcrop	Hillslopes, escarpments	0-20	3-60	6,200 to 6,800
6	Camborthids-Torriorthents	Plains, hillslopes	6-40	1-12	6,400 to 7,000
7	Haplargids-Torriorthents-Rock outcrop	Plains, hillslopes, canyon walls	0-40	1-60	6,200 to 7,000
8	Haplargids	Plains	15-60	1-20	6,400 to 7,900
<u> </u>	MODERATELY DARK COLORED SOILS	OF THE COOL PLATEAU REGION			
9	Torrifluvents-Haplargids-Haplustolls	Flood plain, plains, valley floors	>60	0-3	6,200 to 7,400
10	Argiustolis-Haplustalfs-Rock outcrop	Plains, hillslopes, escarpments	0-40	0-30	7,100 to 7,800
11	Rockland-Torriorthents-Argiustolls	Hillslopes, escarpments	0-20	2-75	7,000 to 7,500
12	Lava rockland	Rock, broken land surface	_	2-10	7,000 to 7,500
	MODERATELY DARK AND DARK COL	ORED SOILS OF THE COOL TO COLD MOUN	TAIN REGION		
13	Rock outcrop-Haplustolls-Argiustolls	Canyon walls, hillslopes	0-20	5-70	6,000 to 7,500
14	Eutroboralfs-Argiborolls	Mountain slopes	10-40	5-40	7,500 to 8,500
15	Eutroboralfs-Ustorthents	Mountain slopes	10-50	2-40	7,000 to 9,000
16	Argiborolls-Cryoborolls-Ustorthents	Mountain slopes	15-60	2-40	7,000 to 9,800
17	Cryoboralfs-Paleboralfs-Eutroboralfs	Mountain slopes	20-60	10-75	8,500 to 11,300
18	Argiustolls-Rockland	Basalt-capped mesas, lava flows, volcanic hills, escarpments	0-40	0-75	7,000 to 8,500